

**Four Decades**  
of  
**The Department of Statistics, Calcutta University**

*( A Brief Outline of its History and Activities during 1941-1980 )*



UNIVERSITY OF CALCUTTA  
1981



Four Decades

of

The Department of Statistics, Calcutta University

A Study of the History and Development of Statistics in India

Issued May, 1981

6s 3552

730V 3423

Printed by 'Mudranika'  
13A, Bepin Pal Road  
Calcutta-700026

1981

## Foreword

The Department of Statistics was created under very unusual circumstances in 1941. The devastating Second World War was continuing. In South East Asia India was very much involved. Calcutta was exposed to the risk of being bombed at any time. Educational institutions and various other establishments were shifted to safer zones.

Dr. Shymaprasad Mukherjee, the then president of the Post-Graduate Executive Council of the Calcutta University could foresee the prospect of Statistics in India in near future. So he suggested to Prof. P. C. Mahalanobis that a full-fledged statistics department could be started in the Calcutta University immediately though he was well aware of the unfavourable situation prevailing in the country at that time. This clearly shows the vision of that great administrator in the field of education. Prof. Mahalanobis readily agreed to start the department. At that time there was acute shortage of space in the campus and further, due to emergency, the University was suffering from financial crisis. Books and equipments were not available. The department was started in July 1941 as a part of the Indian Statistical Institute which was then located in the Presidency College. Professor P. C. Mahalanobis became the first head of the department. This arrangement continued till 1945, when the department was shifted to Asutosh Buildings. The department received a severe blow in 1950 when the two stalwarts Prof. R. C. Bose and Prof. S. N. Roy left the department and migrated to U.S.A. permanently. I would like to put it on record that the department could continue its academic programme due to the unstinted support received from Dr. Pramatha Nath Banerjee, former Vice-Chancellor ; Prof. Satish Chandra Ghosh, former Registrar and Treasurer ; Prof. Nikhil Ranjan Sen, former Head of the Department of Applied Mathematics and Sri Sailendra Nath Mitra, former Secretary of the Post-Graduate Council. With their assistance the department could be stabilized. We remember with gratitude the invaluable support and guidance we received from them.



#### IV FOREWORD

The department continued its existence in Asutosh Buildings till 1964, when it was shifted to its present location in the Ballygunge Science College.

In more than one sense this period of four decades (from July, 1941 to May, 1981) is the culmination of one stage of its continuous process of evolution and growth. The old guards who worked with determination and devotion for the last forty years for making the department one of the leading centres of statistics in the world are no longer in the main stream of activities of the department but their efforts are recorded in this brochure.

This is a document which has depicted not only the growth of the department but also the growth of Statistical Science in India.

This publication, I hope, will act as a source of inspiration and guidance to the present generation to whom we are leaving the charge with confidence.

*Department of Statistics,  
Calcutta University,  
May 30, 1981*

**Purnendu Kumar Bose**  
*Centenary Professor and Head*



## Compiler's plea

'Four Decades' is mostly a compilation work of the history and activities of the Department of Statistics, Calcutta University from its inception in 1941 up till now, covering a period of about 40 years. Prof. P. K. Bose had long in his mind the idea of bringing out a brochure like this. Out of his usual affection for and confidence in me, he wanted me to get it compiled from all available records in various files and reports of the department without further delay, since some vital information, linking-up the different aspects of the department are likely to be lost forever, when the persons involved with and capable of interpreting them cannot be found close at hand. Moreover, there is a potential need and utility of such a publication for the present as well as for future use.

Evidently a history of the development and activities of an institution has always elements of interest and inspiration for all who have love and respect for it.

I was fully aware of my limitations in respect of this compilation work and could complete it but for the valuable suggestions, spontaneous help and necessary facilities from the Head of the Department, Prof. P. K. Bose and from all the teachers, particularly, Prof. H. K. Nandi, Sri P. K. Banerjee, Prof. S. K. Chatterjee and Dr. S. P. Mukherjee. Sri P. K. Mitra, the Senior Office Assistant of our department, extended his active co-operation whenever needed. I also received a good deal of encouragement, from all my departmental colleagues, in this work.

I spared no personal effort to make the publication useful and informative as far as practicable. Some undesirable errors, inconsistencies and other shortcomings might have crept in, partly due to the inherent lapses in the source materials and partly for the lack of my prior experience in editing such a work.

Messrs. Mudranika of Calcutta gladly helped us in every way to make the brochure more attractive and less defective and to get it printed in a very short time.

We are confident of the usefulness of this brochure to the students, teachers and all whosoever have any interest in the affairs of the Department of Statistics, Calcutta University

*Department of Statistics,  
Calcutta University,  
May, 1981.*

**P. JANA**  
*Departmental Librarian*

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The Pioneer :  
PROF. P. C. MAHALANOBIS  
*Head of the Department (1941-1945)*



# 1 The First Phase : 1941—1950

## 1.1 THE INCEPTION

It was in 1940 that Dr. Syamaprasad Mukherjee, the then President of the Executive Council, Calcutta University, informed Prof. P. C. Mahalanobis that the University would like to start the Department of Statistics, along with the Geography Department, from the 1941-42 session, provided Prof. Mahalanobis could send a proposal for the same. In October 1940, all senior workers of the Indian Statistical Institute, including Prof. P. C. Mahalanobis, Prof. R. C. Bose, and Prof. S. N. Roy met at Giridih to prepare a model syllabus for the post-graduate course in statistics and also a list of text books<sup>1</sup> which would be used by the students. In due course the proposal was submitted by Prof. Mahalanobis and the University agreed to create the new department of statistics. So the Post Graduate Department of Statistics, Calcutta University was started in July 1941 with inadequate physical facilities. This was the first full-fledged post-graduate department in statistics in India teaching statistics as a separate discipline. For a long time this department provided the initial inspiration and gradually similar departments were coming up in other universities in the country. Even when this department was opened, there were a very few centres in the world, where statistics was taught separately.

The newly-born department had to face a number of acute problems in respect of space, staff, finance, books<sup>2</sup> and the laboratory. It had to use the lecture rooms of the Presidency College for holding the theoretical classes while the practical classes were conducted in the space provided by the Indian Statistical Institute. It also provided accommodation for the staff and allowed the students to use its library and calculating machines.

The department started with a meagre staff with Prof. P. C. Mahalanobis as the Honorary Head. Initially there was only one whole time lecturer, one assistant lecturer and two part-time lecturers in the department. The University sanctioned an annual contingency grant of Rs. 1200/- only. The part-time lecturers were whole-time employees of the Indian Statistical Institute.

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<sup>1</sup> See appendix—II.

<sup>2</sup> In the beginning, quite a number of books and relevant portions of a few others required to be photo-copied for the use of students and teachers, because of the unavailability of the same on account of the prevailing Second World War.



## 1.2 THE STUDENTS AND THE MODE OF TEACHING

Twelve students were admitted to the 5th year class in 1941, of whom six continued till the final examination. The post-graduate course<sup>1</sup> in statistics at the beginning consisted of 5 theoretical papers and 3 practical papers of 100 marks each. There was a provision for 3 special groups, out of which two were introduced in 1941, but from 1944 the course was restructured and all papers were considered as compulsory ones. One student in the first batch was allowed to submit a thesis in lieu of two papers. Prof. Mahalanobis was not taking any regular classes but he used to take some special classes where he explained the usefulness of statistics for solving the various problems of practical importance. Prof. R. C. Bose and Prof. S. N. Roy were shouldering the main burden of teaching.

From 1944 onwards right upto 1950 there was a tremendous rush for admission in the post-graduate statistics class. During this period, about 150 applications were received every year for admission from different states of India, and for final selection the department had to organise admission tests. The department had on its rolls students from Kashmir to Kerala—covering almost all states of India.

## 1.3 A CRITICAL TIME

Till the end of 1945 the Department had no accommodation of its own and practically it was running with the Indian Statistical Institute<sup>2</sup>. Prof. P. C. Mahalanobis, who was so long at the helm of affairs of the Department, relinquished his headship in 1945 due to his heavy burden of work in the Indian Statistical Institute and elsewhere and Dr. R. C. Bose succeeded him as the head of the Department. The Department was then shifted from the Baker Laboratory, Presidency College to the first floor of Asutosh Buildings, Calcutta University. The space provided was extremely insufficient and the department could somehow maintain its academic activities with considerable difficulties. Prof. R. C. Bose remained in the same post, until he left for U. S. A. in 1949. After that Prof. S. N. Roy took over charge of the department and continued only upto 1950. Subsequently after that he had to leave for U. S. A. to join a permanent assignment of professor of statistics in the University of North Carolina. His predecessor, Prof. R. C. Bose, was already working there as a Professor of Statistics.

Dr. R. C. Bose submitted to the University a development plan in 1946. It reveals a dismal picture relating to the space occupied by the department, the strength of the teaching and the non-teaching staff and the equipments

<sup>1</sup> See appendix—12.

<sup>2</sup> Early in 1942, the department had to shift temporarily for a few months along with the Indian Statistical Institute, to Giridih, due to the worsening war situations.



owned by it at that time. It is also recorded that a total floor space of 1582 sq. ft. (consisting of 2 lecture rooms, 1 sitting room for the whole-time lecturers, 1 office room also used simultaneously by the part-time and assistant lecturers and 1 practical class room) was being used by the department, of which practically 362 sq. ft. of floor space in the Asutosh Buildings, Calcutta University (i.e. the office room and the practical room) only was under its undisputed authority. It had to share a floor space of 1040 sq. ft. (comprising 2 lecture rooms) with the Physics and Statistics departments of the Presidency College and a floor space of 180 sq. ft. (which was used as the sitting room for whole time lecturers) with the Statistical Laboratory of the Indian Statistical Institute, then situated in the same Institution. The teaching staff consisted of two whole time lecturers (of whom one was officiating as the Head of the Department), one assistant lecturer and 4 part-time lecturers of two categories divided according to their pay. The office was initially staffed with only one literate duftry and one bearer. And six calculating machines, one Gestetner duplicator and a type writer were all the equipments that belonged to the department at that time (around 1946, when the department was already 5 years old).<sup>1</sup>

#### 1.4 THE TEACHERS

The names of the teachers attached to the department during the period under review as whole-time or honorary lecturers were Prof. P. C. Mahalanobis, Dr. R. C. Bose, Prof. S. N. Roy, Dr. P. K. Bose, Sri H. K. Nandi, Sri A. Bhattacharyya, Sri B. N. Ghosh, Sri M. N. Ghosh, Sri A. C. Das, Prof. C. R. Rao, Dr. K. R. Nair, Sri S. Sengupta, Prof. M. Chakrabarti, Sri N. K. Chakrabarti and Mrs. C. Bose.

#### 1.5 RESEARCH ACTIVITIES OF THE TEACHERS

In the field of research, during the years 1941-1950 the teachers of this department made fundamental contributions in (i) Design and analysis of experiments, (ii) Multi-variate analysis, (iii) Estimation and testing of hypothesis, (iv) Construction of statistical tables and evaluation of power functions, (v) Topographic variations and statistical fields and (vi) Problems of sample surveys.

Dr. R. C. Bose developed a systematic theory for analysing statistical experiments well known as 'Theory of Linear Estimation'. This was extended to the case of correlated variables by C. R. Rao. Construction of various types of designs for laying out experiments, involving combinatorial methods was systematically studied by Dr. R. C. Bose. This afforded solutions to many classes of useful designs. A number of important results in number theory arising in this connection were also obtained.

<sup>1</sup> See appendix—1 for the present area and equipments.



Significant contributions to design and analysis of factorial experiments were made also by Sri K. R. Nair and Sri C. R. Rao. Problems of enumeration of Balanced Incomplete Block Designs was tackled to some extent by Sri H. K. Nandi.

Prof. S. N. Roy developed the method of statistical analysis of multivariate data and obtained the sampling distributions of requisite statistics and also studied the power functions of these tests.

Sri A. Bhattacharyya, who later joined the Presidency College, Calcutta made significant contributions to the problem of estimation in a series of papers. Results presented, showed an improvement on the lower bound of variances of estimates.

The problem of testing of composite hypothesis was investigated by Prof. S. N. Roy and Sri M. N. Ghosh. They succeeded in showing how such tests could be obtained under slightly more general conditions than those already known. The status of the commoner statistical tests from the power function stand-point was studied by Sri H. K. Nandi. Sri M. N. Ghosh developed nonparametric tests for random 2-dimensional fields.

The main difficulty in applying advanced statistical tests was the non-existence of relevant statistical tables which could be readily used. Dr. P. K. Bose filled up an important gap by constructing tables containing confidence intervals and significance levels for classical  $D^2$ -Statistic. Tables of hypergeometric functions which are so useful for tabulation of the significance levels of non-central F and Studentised  $D^2$  etc. were extended by Dr. P. K. Bose. The power functions of F, t, r statistics were also numerically evaluated.

On the topics of topographic variation and methodology of sample survey, a good deal of work was done by Sri B. N. Ghosh. He considered the efficiency of sampling units of different types of fields and among different measures for topographic variation. Sri A. C. Das made an investigation of the various types of Systematic Sampling from a two-dimensional field.

Prof. R. C. Bose obtained D. Litt. in 1947 for his thesis 'Some Combinatorial problems of the design of experiments' from the University of Calcutta. Dr. P. K. Bose received his D. Phil. degree from the same university on his thesis 'Parametric relations and statistical tables for the distribution functions of classical and studentised  $D^2$  statistics and the use of these distribution functions as graduating populations for frequency data' in 1948. Incidentally it may be mentioned that they were the first recipients of a doctorate degree in statistics from any Indian University.





Two Stalwarts :\*

PROF. R. A. FISHER & PROF. P. C. MAHALANOBIS  
(Sometime in 1945)



PROF. R. C. BOSE  
*Head of the Department*  
(1945-1949)



PROF. S. N. ROY  
*Head of the Department*  
(1949-1950)





## 1.6 PUBLICATION OF THE CALCUTTA STATISTICAL ASSOCIATION BULLETIN

The members of the teaching staff of the department in co-operation with the Calcutta Statistical Association started publishing a quarterly journal from August 1947, containing information and expository articles on various statistical topics, which has had a favourable reception both in India and abroad. Dr. P. K. Bose was the Secretary of the Association at that time.

## 1.7 A DISTINGUISHED VISITOR

Prof. R. A. Fisher, Sc. D., F. R. S. of the Department of Genetics, Cambridge University, visited the department sometimes in 1945.

## 2 The Second Phase : 1951—1960

### 2.1 THE BACKGROUND

From the beginning of the second phase i.e. from early 1951, the department continued its progress under the guidance of Dr. P. K. Bose. He had the opportunity of working in a congenial atmosphere all along with full co-operation from the dedicated and enthusiastic fellow teachers like Sri H. K. Nandi, Sri B. N. Ghosh, Sri P. K. Banerjee, Dr. M. N. Ghosh, Dr. S. B. Chaudhury and others.

It was already stated that Prof. R. C. Bose and Prof. S. N. Roy left the department permanently for U. S. A. by 1950. On account of the sudden departure of the two eminent teachers, the academic work of the department suffered greatly for the time being. Dr. P. K. Bose and Sri H. K. Nandi had to take the major teaching load for running the classes. Sri H. K. Nandi, though comparatively young at that time, endeared himself to all by his scholarship, steadfastness and masterly teaching. He also shared a major responsibility in the administration of the department.

Initially the department occupied only two small rooms in the Asutosh Building in 1945 and from 1949 it had another big room in the same building and afterwards in 1951 one more lecture room was also allotted to it. Practically there was no library in its usual sense, when the department started. A small library could be built towards 1950 and by 1955 the department had a moderately good library. All the back volumes of the Journal of Royal Statistical Society, Series A & B., were transferred to the department from the University Central Library, through special arrangements. Since the department came into being during the Second World War period, no calculating machines could be procured. From 1950 onwards, however, a number of calculating machines, of which some were electrically operated, were purchased.

### 2.2 THE TEACHERS AND THE TOPICS TAUGHT

During the years 1951 to 1960, the department had the following teachers with their relevant designations given against each of them. In addition to Dr. P. K. Bose (reader and head of the department), Dr. M. N. Ghosh (a whole-time lecturer), Sri H. K. Nandi (first a whole-time lecturer, after-wards a reader), Sri A. C. Das (a part-time lecturer), Sri B. N. Ghosh





(first an honorary lecturer, afterwards a whole-time lecturer), Dr. A. K. Gayen (a part-time lecturer), Dr. A. C. Nag (a part-time lecturer) Dr. K. N. Bhattacharyya (an honorary lecturer all along), Dr. S. B. Chaudhuri (a part-time lecturer), Sri T. Chaudhuri and Sri P. K. Banerjee (first an honorary lecturer, then a whole time lecturer) were among the members of the teaching staff throughout or at different stages of the period mentioned. Dr. K. C. Seal (a part-time lecturer) and Sri M. K. Gupta (a part-time lecturer) too belonged to the teaching staff for some time. Sri B. N. Ghosh was on leave from the 28th October, 1957 due to his sudden illness and Dr. K. C. Seal resigned on the 31st August, 1957.

On account of the lack of adequate number of teachers, accommodation and library facilities, only a general course in applied and theoretical statistics was being imparted to the post-graduate students. The topics covered were Statistical Methods, Probability and Mathematics, Numerical Analysis, Economic Statistics, Psychometric Analysis, Theory of Inference, Theory of Distributions, Large Sample Theory, Vital Statistics, Genetics, Quality Control, Design of Experiments, Linear Estimation and Sample Survey.

The coverage of the subjects with the corresponding teachers taking them, throughout or during the periods of their stay in the decade in question were as follows. Subjects such as Statistical Methods, Numerical Analysis, Psychometric Analysis and Biological Assay, Quality Control were mainly taught by Dr. P. K. Bose, while Sri H. K. Nandi had to take Mathematical Analysis, Mathematical Statistics, Statistical Inference and Design of Experiments. Sri P.K. Banerjee was usually concerned with the subjects of Probability, Economic and Official Statistics and Sample Survey. Dr. A. C. Nag taught Numerical Analysis and Vital Statistics, and Sri S. B. Chaudhuri had to deal with Statistical Methods, Statistical Quality Control etc.. Dr. K. N. Bhattacharyya was all along confined with Design of Experiments. Sri M. K. Gupta used to take Algebra, Dr. M. N. Ghosh Mathematical Analysis, Probability and Mathematical Statistics, Sri B. N. Ghosh Sampling Methods and Sample Surveys, Dr. A. K. Gayen Genetics, Quality Control, Statistical Methods, and Dr. K. C. Seal Algebra and Genetics respectively.

The teaching load on the faculty was of about 25 hours of lecture to the fifth year class and 25 hours to the sixth year class per week. A two-year general course on theoretical and applied statistics was taught to a class of about twenty students. In the practical classes the students were guided to solve problems involving application of statistics to diverse branches of natural and social sciences.<sup>1</sup>

<sup>1</sup> See appendix—12.



### 2.3. RESEARCH ACTIVITIES OF THE TEACHERS

Members of the teaching staff were engaged in researches mainly in such topics as Mathematical Statistics, Theory of Inference, Nonparametric tests, Decision Problems, Design of Experiments, Psychometric Analysis, Numerical Analysis, Theory of Sampling and Sample Survey, Multivariate Analysis, Statistical aspects of planning along with statistical analysis of education problems, population statistics, construction of statistical tables, testing of hypotheses, topographic variations and so on.

Dr. P. K. Bose worked on the construction of statistical tables. Under his guidance Sri S. B. Chaudhuri, formerly a research student and afterwards a part-time teacher of the department, completed a set of tables for the confidence interval of classical  $D^2$  statistics. Dr. Bose also investigated various problems which arise in psychometric analysis, and was able to evolve a new method to test the adequacy of behaviour models with the help of reliability coefficient and to formulate the statistical criteria for a standardised test. He obtained useful results concerning normalization of frequency functions. Dr. P. K. Bose and Sri S. B. Chaudhuri suggested a scaling procedure in stochastic and vocational tests. They also investigated the possibility of constructing the statistical tables for  $p$ -statistic. One of Dr. Bose's student, Dr. M. K. Ganguli, worked under him and made important contribution in extending the scope of the relaxation method to deal with equations in three dimensions. Dr. Bose also evolved the method of equipercentile curve to control "inter-test variation" in Examination System and he utilised the concept of statistical control chart to control "inter-test variation" in the system mentioned. Two Research fellows of the Psychology Department, Sri Asis Bose and Sri Ranjit Majumder worked on these topics. This method was applied on a random sample of candidates appearing at the Intermediate Examination of the Calcutta University. Marks of the three papers of English, set at the School Final Examination, conducted by the Board of Secondary Education were statistically analysed to examine whether the tests satisfy the three criteria of consistency, efficiency and sufficiency which are the requisites of a standardised test.

Sri H. K. Nandi investigated the problem of combination of tests of significance and the optimum properties of conditional tests of significance. Later he continued his work in composite hypotheses. He also conducted some researches in combinatorial problems in design of experiments. He made a critical study of the project on National Sample Survey now in operation all over the country. Sri H. K. Nandi made significant contributions towards a new approach to the analysis of variance problems, test



of joint hypotheses and a study of the optimum properties of the usually applied tests. He studied a group of compound decision problems and obtained a class of optimum decision procedures under certain simple loss functions. Sri S. K. Chatterjee, working under Sri H. K. Nandi, studied some two-sample procedures for constructing tests with nuisance parameter free power and confidence intervals of fixed span and arrived at some results. Sri J. K. Ghosh, another research student under Shri Nandi, dealt with the problem of optimum allocation of sampling units in stratified sampling, where several variables are to be considered simultaneously, and derived some preliminary results. Sri P. K. Sen also worked under Sri H. K. Nandi and investigated the existence of moments of order statistics and their convergence to those of the asymptotic distribution.

Sri A. C. Das continued his work on multivariate analysis and canonical correlations. He studied systematic sampling and made some useful investigations.

Sri B. N. Ghosh was engaged with his study of topographic variation and the related problems of sample survey. He analysed the form of a variance function in real life sampling.

Sri M. N. Ghosh obtained an upper limit for the expected length of the shortest path among  $n$ -points in a two-dimensional field—an useful result in the cost analysis of sample surveys. He evolved a test of field uniformity by space correlation method and showed that its limiting distribution under certain conditions tends to the normal form. He studied a group of non-parametric tests based on serial statistics which have important application in non-parametric tests. He also made a thorough investigation into the transport problems as envisaged in the Second Five Year Plan. During 1954, Sri Ghosh obtained the D. Phil degree from the Calcutta University on his thesis 'contribution to non-parametric tests of hypothesis and decision theory'.

Dr. A. K. Gayen continued his previous work in non-normal sampling distribution. He also did some work in vital statistics and time series analysis. He made a useful study of the problem of determination of item weights in personality tests.

Sri A.C. Nag continued his work on population statistics. He submitted a thesis entitled 'A demographic study of Bengali Hindus' for the D. Phil degree.

Dr. K. C. Seal made important contributions in several sampling problems in sample survey, certain decision problems connected with design of experiments and established some properties of order statistics taken from several symmetrical populations.



Sri P. M. Roy and Sri P. K. Bhattacharyya, working under Sri H. K. Nandi, obtained significant results concerning the construction and analysis of design of experiments and arrived at the solution of certain decision problems connected with the classification of normal populations.

Sri P. K. Banerjee was engaged in studying various problems in the fields of large scale sample surveys and statistical quality control.

#### 2.4 PARTICIPATION AND INVOLVEMENT OF TEACHERS IN CONFERENCES ETC.

Dr. P. K. Bose, Head of the Department, was invited to the International Congress of Mathematicians, held at Amsterdam in 1954. He also attended the German Statistical Conference in Trier. He made an extensive tour of Western Europe and England and saw the type of statistical training and research in those countries. He met Prof. R. A. Fisher in Cambridge, Dr. Yates in Rothamsted, Prof. Pearson in London and Prof. Aitken in Edinburgh. Dr. Bose also presided over the Statistics Section of the Indian Science Congress at Calcutta in January 1957. He was invited by the Indian Statistical Institute to deliver a special lecture on the occasion of its Silver Jubilee Celebration. Dr. Bose also attended the meetings of the Statistical Committee of the Indian Council of Agricultural Research, New Delhi. He attended the meetings of the Agro-Economic Research Centre, Visva-Varati, as a member of the Indian Central Jute Committee to review the statistical work carried out by the Committee. He was also invited by the Visiting Committee of the Indian Institute of Technology, Kharagpur, to give opinion regarding the reorganisation of the Statistics Department.

Dr. M. N. Ghosh was invited to the post of Visiting Professorship in the University of North Carolina in 1954.

Sri H. K. Nandi acted as the recorder in the Statistics section of the Indian Science Congress in 1954, while Sri P. K. Banerjee held the same office in January 1960.

Dr. A. K. Gayen participated in a Symposium on "Objective Tests in India" organised by the authorities of the David Hare Training College, Calcutta in 1952, where he read a paper on "Personality". Sri T. Chaudhury, a part-time teacher in the department joined the London School of Economics for further studies in Economic Statistics in 1953.

#### 2.5 RESEARCH SCHOLARS AND THEIR LINES OF RESEARCH

For the first time two research scholars, Sri Atindra Mohan Gun and Sri Prodyot Kumar Bhattacharyya were appointed in the scheme of the Government of India Research Training Scholarship and they commenced their work



under the guidance of Dr. P. K. Bose and Sri H. K. Nandi respectively. Sri M. K. Ganguli and Sri A. Ghosal, two former students of the department, completed their Ph. D. work under Dr. P. K. Bose. Sri Ganguli worked on "Application of Relaxation Method for solving problems in Hydro-dynamical Model" and Sri Ghosal worked on "Use of O. R. techniques in Storage Problems". Both of them obtained their D. Phil degrees.

Sri P. M. Roy, another ex-student of the department, worked under Sri H. K. Nandi on "Design of Experiments" for his D. Phil degree and also obtained it duly in 1957 for his thesis "On some Combinatorial Problems in the Design of Experiments". Sri S. K. Chatterjee, Sri P. K. Sen and Sri J. K. Ghosh registered themselves as research fellows under Sri H. K. Nandi towards the end of this period. Sri P. K. Bhattacharyya completed his work and submitted his thesis on "Optimum Properties of some decision Procedures" for his D. Phil degree and was awarded the same in 1960. Sri S. B. Chaudhuri, a part-time teacher of the department, registered for the D. Phil degree under Dr. P. K. Bose.

## 2.6 A FEW LIMITATIONS

Teaching load of the members of the teaching staff being heavy and there being only two or three research scholars, facilities for research were also limited. For developing research in applied fields, the need of workers in the rank of research investigators, a small unit of permanent workers for survey work etc., was keenly felt. Computer facilities were not available.

## 2.7 OFF THE TRACK SERVICES

The department attended to a number of statistical queries from government departments and a number of research institutions. The members of the teaching staff gave advice and guidance in statistical analysis of agricultural and psychological experiments, sample survey data etc.

The department helped the Indian Society for Quality Control in organising a short evening course on Statistical Quality Control for technicians working in different industries.

The department co-operated with the Calcutta Statistical Association, in its publication of the quarterly journal: 'Calcutta Statistical Association Bulletin' as before.

In 1954 at the initiative of the Vice-Chancellor, Dr. J. C. Ghosh, the department carried out an enquiry, by sampling method, into the conditions of college students in Calcutta, in co-operation with other departments of this university. A report on the results of the enquiry was published.





The department also co-operated with the Department of Economics, Calcutta University in a research project on Socio-economic enquiry in Calcutta over five years, financed by the Planning Commission of the Government of India during 1954-55.

Some members of the teaching staff took part in the training scheme of the Institute of Social Welfare and Business Management during this period.

A five year scheme of research on examinations was undertaken by the department jointly with the Indian Institute of Technology, Kharagpur, in 1956, under the auspices of the Ministry of Education, Government of India.

In 1959, the department undertook a project on 'Evaluation of Benefits of Irrigation' jointly with Department of Economics and sponsored by the Planning Commission, Government of India.

## 2.8 IMPORTANT EVENTS

The first and second Calcutta University Statistics Students' Reunion were held in a befitting manner in 1952 and 1954 respectively.

## 2.9 DISTINGUISHED VISITORS

Prof. J. B. S. Haldane, F. R. S. of the University College, London visited the department in 1954.

Dr. P. V. Sukhatme, Head of the Statistical Division, Food and Agricultural Organisation, United Nations came to the department in 1954-55 and delivered a lecture on "Functions of FAO (Statistical Division)."

Prof. G. A. Barnard, Professor of Statistics, Imperial College, London & Prof. J. Neyman, Professor of Statistics, University of California, U. S. A. visited the department during 1956-57. Prof. Barnard gave a talk on "Development of Statistical Inference," while Prof. Neyman's lecture was on "Statistical Study of the Problems of Expanding Universe."

Prof. Ellis Ott of U.S.A., came to the department in 1958 and gave a lecture on "Statistical Quality Control".

Dr. V. G. Panse, Statistical Adviser, Indian Council of Agricultural Research, Govt. of India, New Delhi also visited the Department in 1959.

Mr. R. R. Juneja, Technical Advisor, Messrs Philips India (Pvt.) Ltd., visited the Department in 1960 and delivered a lecture on "Statistical Quality Control".



### 3 The Third Phase : 1961—1970

#### 3.1 SOME IMPORTANT ASPECTS

The decade comprising the years 1961 to 1970 will be always considered very significant and glorious in the history of the department due to several reasons.

Firstly, a number of young teachers, like Prof. S. K Chatterjee, Dr. P. K. Sen, Dr. J. K. Ghosh, Dr. S. P. Mukherjee, Dr. B. Adhikari, Dr. A. Maitra, Dr. S. R. Chakrabarti, and Dr. A. Chaudhuri, all later renowned for their outstanding scholarships and remarkable contributions, both in India and abroad, started their careers as teachers of this department, during this period. Of course, the department had to let some of them go ultimately, at different times, for their involvement in larger and more prospective fields.

The second reason was that on account of the liberal grants from the University Grants Commission, the Department had its new apartment ready by the end of 1964, covering almost the entire fifth floor of Ballygunge Science College at 35, Ballygunge Circular Road, Calcutta with all necessary furniture, relevant equipments and amenities. During the May holidays of 1965, it shifted from its original congested establishment, consisting of only 3 rooms on the first floor of Ashutosh Building, College Street, in which the department so long struggled for its existence and normal activities. The department also secured a spacious library with adequate grants for purchasing books and journals, with a newly appointed Departmental Librarian to look after it, in course of this period.

The third important aspect of the development of the department during the decade mentioned, was that a project wing was established with some permanent staff viz. a statistician, three computers (one senior and two juniors) and occasional temporary hands as investigators, typists, punch-operators, supervisors etc. as and when needed. A succession of successful survey projects on examination systems, college students, higher secondary education, primary school teachers, engineering industries etc. were undertaken.

The fourth significant point to attract attention was that the old syllabus in statistics, at the graduate and post-graduate levels of the university, was revised and rationalised thoroughly, according to the needs of the day and the advancement of the subject.



Last, but not the least, Prof. P. K. Bose brought a rare and magnificent prestige for this comparatively young and small department, on his appointment as the first Pro-Vice-Chancellor for Academic affairs, of this old and one of the foremost universities of the country. He also visited Japan, U. S. A., U. K., and some other countries of Western Europe and delivered a few lectures as the leader of the 'Quality Control Team' sent by the Government of India in 1962.

### 3.2 THE TEACHERS AND THE TOPICS TAUGHT

The teacher who continued to teach from the first to the last of this period were Prof. P. K. Bose (prof. and head of the department), Sri H. K. Nandi (reader and afterwards the Head towards the end of this period), Sri P. K. Banerjee (reader), Dr. S. B. Chaudhuri (part-time lecturer), and Dr. K. N. Bhattacharyya (honorary lecturer), respectively. Dr. S. K. Chatterjee (reader), who joined in the beginning of this period was temporarily away for about two years around 1967-68. Both Prof. Bose and Sri Nandi were already readers earlier to this decade in question. Dr. P. K. Bose became the Centenary Professor in Statistics, during the later half of 1962. Sri P. K. Banerjee in 1964 and Dr. S. K. Chatterjee in 1969, were promoted to readers. Dr. A. C. Nag, a part-time lecturer and Sri M. K. Gupta, an honorary lecturer continued upto the end of 1961. Dr. P. K. Sen joined as a lecturer in 1962 and remained upto 1965, while Dr. J. K. Ghosh continued for the period from 1963 to 1964. Dr. S. P. Mukherjee and Dr. A. K. Maitra, both were appointed as whole time lecturers in 1964, but Dr. A. K. Maitra joined in 1965 and continued upto 1967, Dr. B. Adhikary and Dr. A. Chaudhury joined in 1967, followed by Dr. S. R. Chakrabarty in 1968. Sri H. K. Nandi became the Head of the Department in 1969 when Prof. P. K. Bose accepted the charge of his new assignment, as the first Pro-Vice-Chancellor for Academic Affairs of this University.

It is very interesting to note that as many as eight teachers viz. Dr. S. B. Chaudhuri, Dr. S. K. Chatterjee, Dr. P. K. Sen, Dr. J. K. Ghosh, Dr. S. P. Mukherjee, Dr. B. Adhikari, Dr. A. Chaudhury, and Dr. S. R. Chakrabarti completed their researches either under Prof. P. K. Bose or Sri H. K. Nandi and submitted their theses just before they joined as lecturers of this department, or while they were working as such. They all obtained their D. Phil/Ph. D. degrees awarded by the University of Calcutta in due course of time. The only exception was Dr. A. K. Maitra, who had his 'Doctorat D Universite' from Paris University.



In order to have an idea about the topics taught by different teachers all along or usually during this period, it appears that Prof. P. K. Bose had been teaching the subjects viz. Statistical Methods, Psychometry, Numerical Analysis, Biological Assay, Industrial Statistics, Statistical Project and Operations Research. Sri H. K. Nandi covered subjects like Mathematical Analysis, Mathematical Statistics, Statistical Inference, Design of Experiments and Large Sample theory. Sri P. K. Banerjee confined himself generally with Probability, Economic Statistics, Official Statistics, Sample Survey and Statistical Project. Dr. A. C. Nag used to teach Numerical Analysis and Vital Statistics and Sri M. K. Gupta was concerned with only Genetics. Dr. S. B. Chaudhuri had to teach Statistical Methods, Statistical Quality Control, Genetics and Numerical Analysis at different times. Dr. S. K. Chatterjee first started teaching such topics as Algebra, Statistical Methods, Design of Experiments but afterwards passed over to Sampling Distributions and Non-parametric Methods. Dr. P. K. Sen used to take such subjects as Algebra, Numerical Analysis, Vital Statistics and Biological Assay. Dr. J. K. Ghosh during his short stay, taught Probability and Statistical methods. Dr. S. P. Mukherjee started his teaching in the department with Vital Statistics, Bioassay, Statistical Project and later he was dealing with Statistical Methods and Quality Control. Dr. A. K. Maitra picked-up the subjects of Algebra and Probability for teaching, with Design of Experiments, Algebra and Linear Estimation. Dr. A. Chaudhuri was assigned to teach Probability first and Dr. S. R. Chakravarty had the responsibility of teaching subjects like Numerical Analysis and Data Processing.

### 3.3 RESEARCH ACTIVITIES OF THE TEACHERS

Prof. P. K. Bose continued his work in Psychometry and Numerical Analysis. Some new problems relating to "Standards of Examination" and "Normalisation Process" were tackled. He also considered some problems relating to "Scaling Procedures" in Psychometry. In this connection he studied the sensitivity of Z-transformation. Prof. Bose and Sri S. P. Mukherjee together worked on problems in Quality Control viz. Control limits from 'Range' in case of 'tool wear' and Economics of Control Chart.

Prof. Bose with the collaboration of Dr. S. K. Chatterjee and Dr. P. K. Sen compiled the history of the Progress of Statistics in India during thirty years, which was included in the Indian Science Congress Association's Golden Jubilee Commemoration Volume, as "Fifty years of Science in India", published in 1962.

Prof. Bose and Sri S. P. Mukherjee investigated into some problems in Industrial Statistics like Role of Management in Quality Activities and



Tool-wear and Process Adjustment. Prof. Bose analysed the major difficulties experienced in conducting large scale public examinations and suggested some methods for solving them. Under his guidance Sri S. Dutt constructed some unifactor tests, analogous to Holzinger's tests, for correlating and predicting scholastic aptitude. Prof Bose and Sri P. K. Banerjee considered some problems relating to India's foreign trade and Sterling Balances during the period 1950 to 1965.

Prof. P. K. Bose and Sri S. P. Mukherjee also considered the problem of simultaneous tests for average and dispersion by Combined Control Charts. They also investigated the problem of controlling a composite characteristic of an industrial product. They prepared two monographs on 'Process Control'.

Prof. Bose with Sri T. K. Mitra and Sm. C. Sen Gupta started an investigation into the comparative study of students' performance in ordinary scholastic tests and in objective tests based on different disciplines. Basic data were provided by Jagadish Bose National Talent Search.

Sri H. K. Nandi and Sri J. K. Ghosh worked on 'Theory of Inference'. The concept of simultaneous confidence interval estimation was extended in an asymptotic sense to prove an optimum property of the maximum likelihood estimates of all regular functions of unknown parameters. It was also used to study the efficiency in designing of linear experiments. Some other problems related to it were investigated. The principles of invariance and sufficiency was used to evolve sequential tests of composite hypotheses. The transitivity of the relevant sequence of statistics was proved under certain conditions and such sequential tests were constructed in a number of commonly occurring multivariate problems. A relation was established between uniformly most powerful tests and shortest confidence intervals in the Neyman's sense.

Sri H. K. Nandi also investigated the conditions for the admissibility of a class of tests in statistical inference and published a paper on the topic. He along with Dr. P. K. Sen studied the optimality of U-statistics for samples from a finite population. Later Sri Nandi pursued his work on the theory of inference relating to the consistency and unbiasedness of the "Union-Intersection" test to those of the individual tests, and completed it.

Sri H. K. Nandi prepared a critical review of work on some aspects of Design of Experiments conducted here over the last twenty years for a symposium volume, published by the Institute of Agricultural Research Statistics, New Delhi. He also evolved a useful generalisation of the two-associate PBIB cyclical association scheme to higher associate classes.



Dr. S. K. Chatterjee worked on the problem of construction of suitable inference procedures for 'awkward' treatment comparisons in the split-plot design, and using the principle of Scheffe's solution to the Fisher-Behren's problem, developed a test and estimation procedure based on "Students" t-distribution. Also, he published some results connected with the sequential procedure for regression parameters, developed earlier. He continued his work on sequential inference procedures with nuisance-parameter-free performance and derived simultaneous confidence intervals for sets of linear parametric functions, the interval-lengths and joint confidence coefficient being predetermined. He also studied the rank property of a certain matrix defined for PBIB designs and investigated certain group-theoretic methods for the construction of PBIB designs. In collaboration with Dr. P. K. Sen, Dr. Chatterjee developed a conditional approach to the solution of a two-sample bivariate location problem and then extended their work to the case of several multivariate distributions. Dr. Chatterjee and Dr. Sen also developed non-parametric methods for testing the identity of association of two bivariate distributions.

Dr. Chatterjee developed nonparametric tests based on U-statistics for the multisample univariate scale problem. Also following a conditional approach he considered a strictly distribution-free test for the bivariate location problem and studied its optimal properties. He examined the feasibility of generating new U-statistics using some standard test statistics as Kernels. In collaboration with Dr. P. K. Sen then at the University of North Carolina, U. S. A., he developed Kolomogorov-Smirnov type tests for the single sample symmetry problem and studied their properties. He also investigated the problem of finding solution to some non-sequential two decision problems based on the idea of 'pseudolikelihood' derived from standard test statistics.

Dr. P. K. Sen originally worked on, 'Some optimum two-sample non-parametric scale tests,' 'An extension of Hoeffding's theorem on the asymptotic normality of U-statistics in a class of problems,' 'Wilcoxon-Mann-Whitney test when both variables are subject to errors,' and 'On the estimation of relative potency in dilution (Biological) assays by distribution-free methods'.

Later Dr. P. K. Sen worked on the various properties of unbiased symmetric estimations (U-statistics) when the observations are not independent. This covered the cases : (i) when the observations are a realisation from an m-dependent stationary stochastic process and (ii) when they form a random sample drawn without replacement from a finite universe, the latter being studied jointly with Sri H. K. Nandi. Some properties of the rank-weighted averages were also studied. Finally, various applications of the non-parametric methods in the estimation of relative potency in direct assay,



were also introduced. In moving average (time-series) schemes too, certain non-parametric tests were considered by him. He also studied along with Dr. S. K. Chatterjee, a class of multisample multivariate non-parametric tests for the location as well as the association problem, before he left for the University of North Carolina for good.

Dr. J. K. Ghosh continued his work in Sequential Tests of composite hypothesis and the application of game theory in Sample Survey. He also characterised Bayes solutions in some sequential problems of two or more decisions and applied the results to determine essentially complete classes under various notions of ordering test procedures. He worked on the existence of invariant minimax procedures when the group-theoretic assumptions of Hunt and Stein are not applicable and also on the relation between existence of consistent tests and termination of SPRT's:

Dr. A. K. Maitra investigated into the problems relating to Subjective Probability and the existence of a measure corresponding to a completely ordered finite set and completed the study of the existence of the numerical values corresponding to the quantitative probabilities of a finite number of events and to the utilities of a finite number of events.

Dr. B. Adhikari derived some new methods for constructing Balanced Block Designs. He continued his investigation into some PBIB association schemes and found some systematic methods of constructing them. He continued his researches in combinatorial problems. He investigated a new type of product of two  $(0,1)$  matrices to utilize them for the construction of new designs and their properties. He also made some systematic study of graph theory and derived a method of generating association schemes using graph products.

Sri A. Chaudhuri carried on researches on problems of sampling from finite population. He derived minimax solutions for some of these problems. He also continued his study to find optimal sampling strategies for estimating finite population totals, and obtained a result concerning the admissibility of the class of uni-cluster sampling designs.

Sri S. R. Chakrabarti carried out his work on multivariate analysis. In particular, he considered the analysis of variance test in multivariate variance component models and also worked on a problem on multivariate analysis of variance from Bayesian point of view.

### 3.4 PARTICIPATION AND INVOLVEMENT OF TEACHERS IN CONFERENCES ETC.

Prof. P. K. Bose attended the meeting of the Statistical Committee of the Institute of Agricultural Research Statistics (I. C. A. R.) as an expert





member for a number of times. He also attended the meetings of the National Productivity Council, New Delhi, as a member on a few occasions. He was invited by the Director, All-India Institute of Hygiene and Public Health, Calcutta to deliver lectures on 'Socio-economic Surveys'. He participated in a Symposium on 'Problems on Higher Secondary Education and Fixation of Career' in the Bose Institute, Calcutta.

Prof. P. K. Bose visited Japan, U. S. A., U. K. and some countries of Western Europe as the leader of the 'Quality Control Team' in 1962. He delivered a few lectures during the tour.

Prof. Bose also attended the meetings of National Council of Educational Research and Training at different times. He presided over two symposia on 'Quality Control' organised by Jamshedpur Productivity Council and Indian Engineering Association, Indian Chamber of Commerce, respectively.

Prof. Bose was Selected as the Chairman of the Committee on 'Quality Control' sponsored by the Indian Standards Institution, Govt. of India, and presided over the meetings of the Committee more than once.

In 1965 Prof. Bose was invited to attend a meeting of the Education Commission and a Convention of The Indian Standards Institution at Bangalore.

Prof. Bose acted as a member of the Co-ordination Committee of U. G. C. for implementation of Education Commission's Report in September, 1966. He also inaugurated the teaching programme of 'data Processing' sponsored by the Calcutta Productivity Council and was the Programme Director of a Seminar on 'Quality Control' organised by Indian Society for Quality Control (I. S. Q. C.) in the same year.

Prof. Bose attended the meetings of the U. G. C. Review Committee on Statistics and in this connection he visited different Indian Universities and a number of industrial and other organisations, during 1968-69. He also presided over a section of the Demographic Seminar sponsored by the State Statistical Bureau, Govt. of West Bengal during this period.

Prof. P. K. Bose was invited by the International Academy for Quality, Japan to preside over a session on 'Sampling Inspection Plan', held in Tokyo in 1969. After the meeting he visited several Universities and Industries in Philippines, Malaysia, Singapore and Thailand.

Sri P. K. Banerjee served as the Recorder of the Statistics Section, Indian Science Congress in 1961.

Prof. Nandi was elected to chair the Statistics Section of the Indian Science Congress Session held at Varanasi in 1968.



Dr. Chatterjee was the Recorder of the Statistics Section of the Indian Science Congress during 1967-68. Dr. Chatterjee attended on invitation the first International Symposium on Nonparametric Techniques in Statistical Inference, held in June 1969, at Indiana University, Bloomington, U. S. A.

Dr. S. P. Mukherjee attended the 11th Annual Conference of the Indian Society of Agricultural Statistics, held in Lucknow in 1968 as a delegate. He visited the Rohtas Industries at Dalmianagar and delivered an address on 'Systems Engineering' at the Dalmianagar Technical Society. Dr. Mukherjee participated in the International Conference on Quality Control held in Tokyo in 1969. He also participated in a Seminar on Agricultural Education held in the Orissa University of Agriculture & Technology, Bhubaneswar, in the same year.

### 3.5 RESEARCH SCHOLARS AND THEIR LINES OF RESEARCH

Both Sri S. B. Chaudhuri and Sri S. K. Chatterjee submitted their theses for D. Phil. (Science) degree in 1961. The title of Sri Chaudhuri's thesis was 'Application of statistical methods in Psychometric analysis and some associated problems in the construction of statistical tables', and that of Sri Chatterjee's thesis was 'Some Sequential (Two-step and Multi-step) Inference Procedures with Nuisance-parameter free Performance in Multi-variate Problems'. Sri Chaudhuri worked under Dr. P. K. Bose and Sri Chatterjee did his research under Prof. P. K. Bose and Sri H. K. Nandi.

Sri P. K. Sen completed his research under Sri H. K. Nandi and obtained his D. Phil. degree in 1963 for his thesis 'Order Statistics and Their Role in Some Problems of Statistical Inference.'

Sri J. K. Ghosh continued his research under Sri H. K. Nandi on 'Theory of Inference'. He submitted his thesis 'Optimum properties of some sequential tests of simple and composite hypothesis and other related inference procedure' for the D. Phil. degree during 1962. He extended his study further in Sequential Tests of composite hypothesis and the application of game theory in Sample Survey.

Sri B. Adhikari investigated different classes of two replicate balanced designs under Sri H. K. Nandi. He generalised the two-associate cyclical association scheme to higher associate classes. Sri Adhikari also obtained significant results on the construction of Balanced Incomplete Block Designs, different types of m-associate PBIB association schemes etc. He completed his D. Phil. thesis on 'Contribution to Incomplete Block Designs' in 1967. He derived a new method for constructing Balanced Incomplete Block Designs.





Sri S. R. Chakrabarti also worked under Sri H. K. Nandi investigating the effect of the inequality of the error variances in the analysis of variance test on the assumption that the error variance is also a random variable. A test for the analysis of variance problem, when the error variances are unequal, had been proposed, based on what had been called "Scheffe" variables in the two-sample case and the properties of this test were investigated. Sri Chakravarty studied, to some extent, into the problems of multivariate analysis of variance when dispersions are different. He completed his D. Phil. thesis on 'Some univariate and multivariate analysis of variance problems' around 1968.

Sri S. P. Mukherjee obtained D. Phil. degree in 1967 for his thesis 'A new approach to the statistical methods for controlling industrial product quality'. He completed his research under Prof. P. K. Bose.

Sri A. Chaudhuri, a lecturer of the department, worked under Sri H. K. Nandi on some problems of sampling and estimation of finite population parameters. He carried on his researches to find optimal sampling strategies for estimating finite population totals and obtained a result concerning the admissibility of the class of uni-cluster sampling designs.

Under Sri H. K. Nandi, two research scholars Sri Bimal Kumar Sinha and Sri Bikash Kumar Sinha, carried out their researches in certain aspects of statistical inference. Some results concerning optimum designing of experiments as well as Bayesian inference were found. Also certain results relating to comparative efficiency of designs, some complete classes of experiments, optimum allocation in regression problems from Bayesian analysis etc. were derived and published.

### 3.6 RESEARCH SCHEMES ETC. IN OPERATION

The department conducted surveys in 1961 concerning the effectiveness of Board and University examinations jointly with Indian Institute of Technology, Kharagpur, under the auspices of the Ministry of Education, Govt. of India.

A fact finding survey 'On the Facilities Available to the Students and Teachers for Study and Work in the Higher Secondary Schools of West Bengal', sponsored by the University of Calcutta and afterwards by National Council of Educational Research and Training, Ministry of Education, Govt. of India, was undertaken by the department and it continued for the period 1961 to 1965.

A survey of colleges affiliated to the Calcutta University sponsored by the Calcutta University was also initiated in 1964. The field work in connection with the survey was complete within the year and the data were

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analysed under the supervision of Prof. P. K. Bose, Sri P. K. Banerjee and Dr. A. K. Maitra. The University Grants Commission took keen interest in this survey and some basic facts relating to colleges were submitted to the Chairman of the said Commission.

The report of the survey on 'Facilities available for study and work to students and teachers in Higher Secondary Schools of West Bengal' was completed jointly by Prof. P. K. Bose, Sri P. K. Banerjee and Sri S. P. Mukherjee and was duly submitted to the Government of India. The report was also released to the press and the important findings and recommendations were published in a number of newspapers and journals. As a sequel to this report Prof. Bose was invited by the Secretary, Education Commission, to discuss some problems relating to secondary education.

The report of the fact finding survey 'Facilities Available for Study and Work in Affiliated Colleges' was jointly prepared by Prof. P. K. Bose, Sri P. K. Banerjee and Sri S. P. Mukherjee and was submitted to the Registrar, Calcutta University.

The department undertook another fact finding enquiry to study the problem faced by small-scale engineering industries located in Howrah Municipality, under the supervision of Prof. P. K. Bose, Sri P. K. Banerjee and Sri S. P. Mukherjee, sponsored by the University of Calcutta, in 1967.

The department also conducted surveys to study the 'Language for Science & Technology Education' and 'Wastage and Stagnation in Collegiate Education' during 1967-68.

Prof. P. K. Bose, Sri P. K. Banerjee and Dr. S. P. Mukherjee were jointly engaged in conducting a sample survey for studying the conditions prevailing in primary schools in West Bengal and the Socio-economic conditions of their teachers. Data in respect of about 1300 primary schools were collected and statistically analysed, by the end of 1970.

The study of wastage and stagnation in colleges affiliated to Calcutta University, commenced in 1968 and was complete by the end of 1970.

### 3.7 OFF-THE-TRACK SERVICES

The department helped in the publication of the Calcutta Statistical Association Bulletin and extended the consultatory services of its teaching staff as usual. It also assisted the Indian Society for Quality Control and the Indian Institute of Social Welfare and Business Management for organising and running their training courses as before. The department co-operated with the departments of psychology, education, and agriculture for teaching courses of statistics.





### 3.8 IMPORTANT EVENTS

Prof. Bose was given a spontaneous and hearty felicitation by his students, admirers and fellow teachers, on the 15th March, 1969, on his appointment as the first Pro-Vice-Chancellor for Academic Affairs of the University of Calcutta.

The 3rd Calcutta University Statistics Students' Reunion was held in the auditorium of the Institute of Jute Technology, Calcutta University at 35, Ballygunge Circular Road, in 1966 with a large number of participants.

### 3.9 THE DISTINGUISHED VISITORS

Dr. S. S. Gould, Executive Editor, 'Mathematical Reviews', The American Mathematical Society, U.S.A. visited the department in 1961.

Prof. R. C. Bose, Professor of Mathematical Statistics, University of North Carolina, U.S.A. came in 1961. He delivered three Special Readership lectures on 'Some Recent Advances in Combinatorial Mathematics' on 4th, 5th and 6th October respectively. His next visit took place in 1966 and this time he delivered the 'S. N. Roy Memorial Lecture' on Coding Theory on the 12th and 13th June, 1966. He came again in 1969 and delivered a lecture on 'calibration design based on the tournament problem'.

Prof. S. N. Roy, Professor of Mathematical Statistics, University of North Carolina, U.S.A. came in 1962 and delivered four Special Readership Lectures on 'Non-Parametric Inference' during 11th to 14th September of the same year.

Prof. Takeshi Suzuki of Tokyo University and Mr. Shin Muira, Chief Quality Control Engineer, Mitsu Chemical Industry Co. Ltd., Japan, visited the department on the 7th July, 1964. They discussed various problems relating to teaching, research and application of Quality Control Techniques in India, with Prof. P. K. Bose, the Head of the Department.

Academician Y. V. Linnik of Leningrand University came to the department and gave a lecture on 'Special Problem in Mathematical Statistics' on 12th January, 1965.

Prof. Wassily Hoeffding of the University of North Carolina, U.S.A., delivered a lecture on 'Asymptotically Optimum Tests for Multinomial Distribution' on 10th March, 1965.

Representatives of the Association of Commonwealth Universities visited the department on 1st February, 1965. They showed keen interest in the statistical reports of the department.

Dr. Robert Young of the Indiana University, U.S.A., visited the Department in September 1965 and discussed about the educational system.





Prof. Inf. Dimitris N. Chorafas, Corporate Consultant in Engineering and Management, Paris and Visiting Professor, Information Science and Business Administration, Washington State University, visited the department on 12th April, 1966.

Prof. Z. Govindarajulu, Associate Professor, Case Institute of Technology, U.S.A., delivered a lecture on Systematic Statistics on the 9th August, 1966.

Dr. R. K. Som, a former student of the department and presently the chief Demographer, United Nations Economic Commission, delivered a lecture on 'Non-Sampling Errors in Demographic Enquiries' on the 28th September, 1966.

Dr. D. Basu, a former student of the department and at present a Statistician, F.A.O., Rome, delivered a lecture on 'Statistical Methods for charting Agricultural Development programme' on the 16th February, 1967.

Dr. S. P. Ghosh, a former student of the department, and now a Senior Executive of the IBM, New York, U.S.A. delivered a lecture on 'Use of electronic computer in filing problems' sometimes in 1969.

Prof. P. K. Sen, a former student of the department and now a Senior Professor of the University of North Carolina, Chapel Hill, U.S.A. delivered a lecture on 'Robust estimation in some linear models' in 1969.

Dr. J. Ay of the Department of Statistics, Budapest University of Economics, visited the department and discussed about the teaching programmes, during 1969.

Dr. Bibhuti Bhusan Bhattacharyya, a former student of the department and now a Senior Professor of the North Carolina State University, U.S.A., delivered a lecture on 'Distribution of strengths of bundles of fibres' in 1970.





PROF. P. K. BOSE  
*Head of the Department*  
(1950-1969, 1976-1981)



PROF. H. K. NANDI  
*Head of the Department*  
(1969-1976)



## 4 The Fourth Phase : 1971—1980

### 4.1 A FEW NOTE-WORTHY FEATURES

The fourth phase comprising the decade from 1971 to 1980, practically extends upto 31st May, 1981, the date on which Prof. P. K. Bose will retire. Prof. Bose was associated with all activities of the department for over four decades, as one of the principal guides. His retirement marks the end of an era or the termination of a traditional line that commenced with Prof. P. C. Mahalanobis. One after another the three seniormost teachers viz. Prof. H. K. Nandi, Sri P. K. Banerjee and Prof. P. K. Bose, the three untiring and devoted care-takers of the department almost since its inception, have retired or will shortly retire, leaving the responsibility of running a full-grown department to the care of their worthy and able students who were nurtured by them for nearly two decades.

This period is particularly important in the sense that twice the M.A./M.Sc. Syllabus in Statistics, was revised to meet the needs of the time. It is also worth noting that the department actively co-operated with Indian Society for Quality Control (I.S.Q.C.) and Indian Association for Productivity, Quality and Reliability (I.A.P.Q.R.) for two national seminars and itself hosted one during this period.

Again it is also to be noted that this department occupied a significant position and attained a considerable maturity and eminence through the activities of its teachers in the fields of research, publication of project reports and participation in national and international conferences in course of this decade.

### 4.2 THE TEACHERS AND THE TOPICS TAUGHT

Prof. P. K. Bose continued to be the Pro-Vice-Chancellor for Academic Affairs upto September, 1976. Prof. H. K. Nandi acted as the Head of the Department during that period. Prof. Bose joined again as the Head of the Department after serving as Pro-Vice-Chancellor for eight years. His retirement as already mentioned, is due on the 31st May, 1981.

The topics taught by Prof. Bose during this period were mainly Psychometry, Operations Research, Industrial Statistics, Computer Science, and Statistical Systems.





Sri H. K. Nandi was appointed as the second professor in the department (U.G.C. Professor of Statistics) in 1972. He continued as the same till 31st December 1978 and voluntarily retired w.e.f. the 1st January, 1979.

Prof. Nandi used to teach topics like Analysis, Statistical Inference and Design of Experiments.

Sri P. K. Banerjee, a senior Reader of the department, retired on 1st March, 1980. He usually taught Economic Statistics and Sample Surveys.

Dr. S. K. Chatterjee, initially a Reader in this period was made a Professor in November, 1979.

Non-parametric Inferences, Testing of Hypothesis, Multivariate Analysis, Design of Experiments, Mathematical Analysis and Statistical Inference are the topics Dr. Chatterjee had been teaching. In 1972 he took leave for one year and worked in the University of North Carolina at Chapel Hill, U.S.A. as a Visiting Associate Professor in the Department of Biostatistics.

Dr. S. P. Mukherjee was promoted to the post of a Reader in 1973. He was involved in teaching Numerical analysis, Large Sample Theory, Demography, Operations Research and Statistical Quality Control at different times.

Dr. B. Adhikari, a lecturer, has been teaching Algebra, Linear Estimation, Design and Analysis of Experiments etc. throughout the period. He joined the Indian Statistical Institute as a Visiting Associate Professor for one year on 17th December, 1980.

Dr. S. R. Chakrabarti, a lecturer, used to teach Distribution Theory and Multivariate Analysis. He left the department on 1st February, 1976 to join the Indian Statistical Institute as an Associate Professor.

Dr. A. Chaudhuri, a lecturer of the department, had to teach topics like Probability, Theory of Sampling from finite population etc. He left on 1st March 1977 to join the Indian Statistical Institute, as an Associate Professor.

Dr. S. B. Chaudhuri, a part-time lecturer for a long time has been teaching Genetical Statistics, Psychometry, Numerical Analysis etc. as and when needed.

Dr. K. N. Bhattacharyya, an Honorary lecturer for many years, used to teach Design of Experiments upto 1973.

Dr. Bikash Kumar Sinha, a lecturer from 1972 was teaching Design of Experiments and Sampling Design. He took leave on 1st September, 1975 to join the University of Bahia, Brazil, as an Associate Professor.





Sri S. K. Sarkar and Sri S. Sengupta both were appointed as lecturers of this department on July 6, 1976. Sri Sarkar was teaching Theory of Inference and Multivariate Analysis. He has taken leave from October, 1980 to join the University of Pittsburg, U.S.A.

Sri Sengupta has been teaching Sampling Distribution, Sample Survey, Multivariate Analysis and theory of Estimation.

Sri N. K. Mandal, a lecturer from 6th April, 1977 has been teaching Probability and Design of Experiments, Linear Models, Demography etc.

Sri K. Das, a lecturer from January 1980, has been teaching Operations Research, Distribution Theory and Algebra.

Sri R. Mukherjee, a lecturer from 17th November, 1980 has to teach Design of Experiments and Testing of Hypothesis.

#### 4.3 RESEARCH ACTIVITIES OF THE TEACHERS

Prof. P. K. Bose, along with Dr. S. P. Mukherjee carried out an analysis of 'Wastage and Stagnation in Collegiate Education'. Prof. Bose acted as the Chairman of the Third National Survey on Higher Education sponsored by the Ministry of Education, Govt. of India and organised by the University Grants Commission. In 1977 Prof. P. K. Bose published a book on 'Higher Education at Cross Roads'. He guided two research projects entitled 'A Techno-Economic Study of Local Skills in West Bengal' and 'Regional Imbalance in Agriculture'. He continued his investigation in Industrial Statistics. Prof. Bose completed a book entitled 'Uncertain Future' in 1978. It dealt with the problem of planning.

Prof. P. K. Bose also served as a technical consultant in the 'Study of Scientific and Technical Manpower for Research and Development in India' sponsored by the Institute of Applied Manpower Research. Dr. S. P. Mukherjee organised and supervised the collection of data from Research and Development Organisations in Eastern India.

Prof. H. K. Nandi guided research scholars—Shri Bikas Kumar Sinha and Shri Bimal Kumar Sinha, in their investigations into certain aspects of comparison of experiments and Bayesian Inference. They duly submitted their theses to the Calcutta University for the Ph. D. degree. Prof. Nandi also guided the research work of two other scholars Shri Satyabrata Pal and Shri Barun Kumar Dutt, on some problems of linear inference and selection procedures. Shri Pal was investigating the main-effect plans in the asymmetrical factorial experiments and nested designs as fractions of asymmetrical factorial. Later Shri Pal extended the results concerning saturated main-effect plans in the symmetrical case. He submitted his thesis entitled 'The Design and Analysis of Factorial Experiments'



duly to the University of Calcutta, for his Ph. D. degree. Shri P. Mukhopadhyay, another research scholar under Prof. Nandi pursued his studies on sampling and estimation problems in finite populations.

Sri P. K. Banerjee continued his work on the design of sample survey and was primarily engaged with various surveys like 'The Cost of Elementary Education in West Bengal', 'Area Skill Survey', etc. He also rendered help to the West Bengal College Enquiry Committee, set up by the Govt. of West Bengal in compilation and statistical analysis of data. He also helped in the finalisation of different project reports.

Dr. S. K. Chatterjee carried out researches along with his students mainly on Non-parametric Inference, Multivariate Analysis and Design of Experiments. He continued his investigations on the robustness of certain chisquared tests. He also investigated certain rank based estimates of the mixing proportion in the multivariate case and used these results to develop classification procedures under the mixture set-up. In collaboration with Sri N. K. De he developed some bivariate location tests against restricted alternatives and investigated their power superiority. He completed his study jointly with Dr. P. K. Sen of the University of North Carolina, U.S.A., relating to the construction and asymptotic theory of non-parametric tests when the observation are progressively censored. He investigated the construction of multivariate tolerance regions based on density estimates with Sri N. K. Patra. In collaboration with Sri P. Chatterjee, Dr. Chatterjee investigated the property of certain symmetrical estimators of variance components for unbalanced data. Shri De completed his thesis duly and was awarded Ph. D. in 1978 from Calcutta University. Dr. Chatterjee guided Sri N. K. Mandal in his study of optimum response surface designs and considered the problem of designing a response surface experiment with a view to locating the optimal point most accurately and obtained some results in the single factor case. Sri K. Das started working under Dr. Chatterjee on the problem of estimation of variance components from unbalanced classification and also obtained some results on the asymptotics of marginal maximum likelihood estimates. Dr. Chatterjee guided Sri R. Mukherjee in his study of effectwise orthogonality in Asymmetric Factorial Designs. Sri Mukherjee completed his thesis and submitted it towards the end of 1980. Sri U. Bandyopadhyay, a lecturer of R. K. M. College, Narendrapur also started working on Sequential Nonparametric Tests under the guidance of Dr. Chatterjee during the period.

Dr. S. P. Mukherjee continued his investigation into the problem of discrimination among the exponential, Weibull and Gamma distributions. He also considered the problem of control of multiple quality characteristics. He investigated some censored sampling plans based on attributes and



variables for reliability demonstration and different aspects of their robustness. Later he worked on some properties of K-Erlang distributions and their uses in life-testing theory. He guided some investigations on Stochastic Programming and Inventory Control.

Along with two research students Sri R. M. Panda and Sri R. K. Chakrabarti, Dr. Mukherjee carried out investigations on some aspects of Inventory Management and prepared a number of papers.

Dr. Mukherjee and Sri B. C. Sasmal studied some problems of Reliability Estimation from variously censored data assuming K-Erlang failure times and investigated some properties of multivariate life-testing models. Dr. Mukherjee prepared a paper on inventory models with inspection and some inventory models with variable supply.

Dr. Mukherjee also pursued along with one of his research scholars Sri S. C. Sarkar, some problems in Goal Programming and related sensitivity analyses. He also studied the role of antithetic variables in sampling from a theoretical population. He continued investigations with Sri R. M. Panda on Sequential Inventory Models with supply against an order as a random variable.

Later with Sri B. C. Sasmal, Dr. Mukherjee worked on the problem of Parameter Estimation for a class of bivariate exponential distributions used in reliability studies. Dr. Mukherjee and Prof. B. R. Dey found out parameters in a price adjusting sampling plan by applying decision theory. He made a joint study with A. Islam of the Aligarh Muslim University, of various properties of a finite range failure-time distribution. He continued researches on problems of inventory management and on dependent system reliability. He helped U. Dasgupta in his studies on productions with multi-stage inputs. An important paper on Stochastic Programming by Dr. Mukherjee was published in the Journal of Operational Research Society (U.K.)

Dr. Mukherjee guided Sri B. N. Agarwal of the Marwari College, Bhagalpur in his researches on Optimal Designs of Continuous Sampling Plans leading to his Ph. D. degree of the Bhagalpur University. Sri L. K. Saran of the same college has been working on Reliability Estimation from stress strength considerations under Dr. Mukherjee's supervision.

Dr. S. P. Mukherjee is guiding Sri M. Bhattacharyya in his research on Stochastic Programming.

Dr. B. Adhikary continued his research in design and analysis of experiments as before. He studied, in particular, restricted Kronecker product method of constructing experimental designs and also cyclical methods of generating cyclic PBIB designs with more than two associate classes.



He proposed some classes of binary, equi-replicate, regular incomplete block designs and investigated the combinatorial properties, method construction and analysis of such designs. He also suggested some methods of constructing Rotable Designs. He studied, jointly with Dr. B. K. Sinha, some optimum properties of group divisible Rotatable Designs.

Dr. Adhikari assisted Sri A. C. Mukhopadhyay in his researches on 'Some Combinatorial Arrangements and Incomplete Block Designs Through Them.' With Sri R. N. Panda he studied the problem of constructing Rotatable Designs. He derived a new type of two associate P. B. I. B. & M. D. P. B. association schemes. Afterwards with Dr. B. K. Sinha he gave the correct analysis and methods of construction of G. D. S. O. R. D. He developed with Sri R. N. Panda a unified approach to the problem of construction of S. O. R. D. and T. O. R. D. He also studied with them various alternative methods of selecting response surface designs, and with Sri P. Das of the Kalyani University he studied F-square and related designs. He also made a systematic study on some aspects of dem curves from family budget data.

Dr. S. R. Chakrabarti continued his research in multivariate analysis as in the previous years and derived some tests in multivariate mixed effects model with incomplete data. He investigated the non-central distribution problem of the likelihood-ratio criterion for testing hypothesis of the identity of several multinormal populations.

Dr. S. R. Chakrabarti visited the Department of Bio-statistics, University of North Carolina, U. S. A., as Assistant Professor and investigated the problems of estimation and test concerning the growth curve model and some step-down procedure in MANOVA model with unequal dispersion matrices.

Sri A. Chaudhuri continued his research under the guidance of Sri H. K. Nandi. He submitted his thesis on 'Some problems in sampling from a finite population.' He further tried to extend it with the specific object of finding suitably optimal classes of sampling designs and determining sampling schemes satisfying some desirable optimality criteria, viz. (i) assessment of the relative performances of known sampling schemes, (ii) determination of sampling schemes realizing optimality conditions on some parameters of sampling strategies and (iii) finding sampling schemes without replacement yielding estimators better than those based on with replacement sampling schemes. Dr. A. Chaudhuri was on study leave from 1973 to 1975 and worked in the University of Sydney, Australia. He resumed his research in the field of sampling theory





relating to finite populations, and obtained some useful results concerning, (i) uniformly admissible and Bayes estimators of finite population variances, (ii) Bayesian sufficiency and invariance of some estimator for finite population parameters and (iii) optimality of certain sampling strategies under certain standard models. Along with two research scholars, Sri Parimal Mukhopadhyay and Sri Raghunath Arnab he also derived some results concerning the problems (a) choosing the sampling size for Horvitz-Thompson estimator, (b) sampling on successive occasions using different strategies, (c) robust estimation of finite population total following Royal's approach and (d) non-negative unbiased estimation of variance functions. He left the department on 1st March, 1977 to join the Indian Statistical Institute.

Dr. Bikas K. Sinha carried on his researches on response surface designs and construction of symmetric 3-associate PBIBD and further extended it to Unified Sampling Theory and Rotatable Designs. He investigated some sampling schemes to realize invariant inclusion probabilities of first two orders. He also studied some discrete power series admitting linearity of regression.

Sri S. K. Sarkar investigated optimum tests regarding the mean vector of a multivariate normal distribution when the observations corresponding to some characters are missing. He carried out his research under Dr. Bimal Kumar Sinha of Indian Statistical Institute and completed his thesis entitled 'Inference from incomplete multivariate samples some testing and related problems' for his Ph. D. degree and submitted it to the Calcutta University in November, 1980 for consideration.

Sri S. Sengupta was prosecuting his research in the field of 'Sample Survey' and studied various problems on (1) Construction of sampling designs and (2) Status of some well known sampling strategies in sampling from finite populations under Dr. B. K. Sinha of Indian Statistical Institute. He has submitted his thesis entitled 'Further studies on some strategies in sampling finite populations,' in November, 1980 to the University of Calcutta.

Sri N. K. Mandal has been continuing his research work in Design of Experiments and in particular studying the problems relating to Response Surface Design under Prof. S. K. Chatterjee.

Sri K. Das has been carrying out his research on the problem of estimation of variance components for unbalanced classification under Prof. S. K. Chatterjee.

Sri R. Mukherjee worked under the guidance of Prof. S. K. Chatterjee on designs of Experiments. He has submitted his thesis entitled 'Asymmetric



factorial designs and allied problems' to the Calcutta University on 10th November, 1980 for Ph. D. degree.

Sri M. Bhattacharyya has been working under Dr. S. P. Mukherjee on Stochastic Programming from May, 1980.

#### 4.4 PARTICIPATION AND INVOLVEMENT OF TEACHERS IN CONFERENCES ETC.

Prof. H. K. Nandi presided over the session on 'forecasting' in a National Seminar on Inventory Management at Jamshedpur in 1973.

Dr. S. P. Mukherjee presided over the session on 'storage and queues' in the 6th Annual Convention of the Operational Research Society of India in New Delhi. He delivered a technical address on Inventory Management in a National Seminar on the subject at Jamshedpur, in 1973.

Prof. P. K. Bose visited Nepal in 1973, being invited by Tribubhan University. In 1974 he visited Bangladesh as a delegate from the Govt. of India.

Prof. P. K. Bose was invited by Humboldt University, G. D. R. in 1974 to visit the country. During this visit he had discussions with the Professors of the Technical University of Dresden and the University of Berlin. He was also invited around this period by IIEP (Paris) to take part in a global discussion on 'Continuing Education'. As a guest of the British Council and Bohr Institute, Prof. Bose visited major Universities of Great Britain and Denmark in 1974.

A number of teachers of the Department took part in an International Symposium, on 'Recent Trends in Statistics,' held in the Indian Statistical Institute, Calcutta, in December, 1974.

Dr. S. K. Chatterjee in collaboration with Sri N. K. De presented a paper in the above symposium incorporating restricted alternatives in non-parametric multivariate tests and the power superiority of the restricted test over the unrestricted tests, obtained for the bivariate case. Dr. S. R. Chakrabarti also presented a paper entitled 'A note on the step-down procedure in MANOVA problem with unequal dispersion matrices' in the said Symposium. Dr. Bikas Kumar Sinha jointly with Dr. Bimal Kumar Sinha presented a paper on the characterization of the dispersion matrix based on the properties of regression at the same Symposium.

Prof. Bose was again invited by IIEP (Paris) in 1975 and also attended the I.A.Q. Meeting in Venice, Italy in the same year he also visited Vienna and Brussels, as a guest of ISO/TC 69 ISI and University of Leaven respectively.





Dr. A. Chaudhuri presented a paper on 'Some applications of the principle of Bayesian sufficiency and invariance to problems with finite populations' at the Symposium on Recent Developments in Survey Methodology held during March 22-27, 1976 at the Indian Statistical Institute, Calcutta.

Dr. S. P. Mukherjee attended the joint IAQ (International Academy of Quality)/EOQC (European Organization for Quality Control) Conference held in Venice during September 16-18, 1975. He also visited several Universities in the U. K. during the same trip as a guest of the British Council.

Dr. S. K. Chatterjee was invited to the All India Seminar on Statistical Inference held at Punjab University in December, 1976 and gave a talk on 'Union-Intersection Technique in Nonparametric Testing' there.

Dr. Mukherjee attended the Fourth International Symposium on Reliability held in Budapest during October 4-7, 1977. He presided over a technical session in the above symposium. He also presented a paper on 'Some general results concerning life-distributions of coherent dependent systems.'

Dr. Chatterjee attended the Regional Meeting No. 160 of the Institute of Mathematical Statistics held in Delhi during December 16-18, 1977 on invitation, and presided over the session on 'Non-parametric Inference.'

Prof. P. K. Bose acted as the Chairman of the third National Survey of Higher Education Sponsored by the Ministry of Education Govt. of India and organised by the University Grants Commission. A report of the survey was duly submitted in 1977. He delivered the B. C. Guha Memorial Lecture on the invitation of the Indian Science Congress at its 64th Session at Bhubaneswar, in January 1977 and the topic of his discussion was 'Population-Food-Nutrition Equation in India'.

Dr. S. P. Mukherjee represented India (Operational Research Society of India) at the International Conference on Operational Research held in October 1978 at Toronto.

A three-day Seminar on 'Quantitative Methods for Decision-Making' sponsored by the University Grants Commission was held in the Department during March 27-29, 1978. Besides teachers and research scholars of the department, 40 participants representing ten universities and their constituent colleges, two institutes of technology and four research organisations, attended the Seminar. In the inaugural session, Prof. G. Kallianpur,



Director, I.S.I., Calcutta, spoke on recursive estimation with reference to telemetric data on satellite movements. Prof. P. K. Bose, Director of the Seminar outlined different decision situations and corresponding optimality criteria. In the First session on 'Subjective Probabilities and Bayesian Decisions' 7 papers were presented. Prof. A. R. Roy, Head of the Department of Statistics, Lucknow University, presided. 'Stochastic Models and Decision-Making' was the subject for discussion in the second session wherein ten speakers participated with Prof. H. K. Nandi, as the chairman for this session. Prof. S. M. Sinha, Head, Department of Operational Research, University of Delhi and Dr. A. Ghosal, Scientist, Council of Scientific & Industrial Research, New Delhi, presided over the morning and afternoon parts of the third session on 'Other Decision Procedures and Their Applications', respectively. Seven papers were discussed in the session. In the plenary session, Dr. S. P. Mukherjee, Convenor, summed up the proceedings of the Seminar.

Prof. Bose was invited to attend the meeting of EOQC at Dresden. GDR in 1978 and also visited Holland, Belgium, France and England in 1978 again as the guest of IIEP (Paris) and the British Council.

Prof. S. K. Chatterjee was invited to give a talk in the seminar on 'Non-parametric Statistics and Inference under order Alternatives' held in Delhi University in April, 1979. Dr. S. P. Mukherjee also presented a talk in the seminar.

Prof. P. K. Bose was invited to participate in a global seminar on the Role of Scientific and Engineering Societies in Development organised by the American Association for the Advancement of Science, the Indian National Science Academy and the Indian Science Congress Association in Delhi in December, 1980.

Prof. S. K. Chatterjee and Sri R. Mukherjee were specially invited to attend an International conference on Probability and Statistical Inference, organised by the Indian Statistical Institute in December, 1980 at Delhi.

Prof. P. K. Bose and Dr. S. P. Mukherjee were invited by the International Institute for Educational Planning (UNESCO) to participate in an International Workshop, on 'Education and Employment in Bangladesh' at Dacca in November, 1980 as reviewers of the Study.

Prof. P. K. Bose, presided over a technical session of a two-day conference on Productivity in Textile Industry organised in Calcutta by the Indian Association for Productivity, Quality and Reliability in Collaboration with the Indian Jute Industries Research Association, Calcutta during November, 21-22, 1980.



#### 4.5 RESEARCH SCHOLARS AND THEIR LINES OF RESEARCH

Most of the research scholars during this period were attached either to the department and other educational institutions as teachers or employees of different Government Offices. Some of them started their research as a regular scholar of the department but later many of them were absorbed as teachers of the department before or just after the submission of their thesis. The guides were generally the teachers of the department, though some teachers attached to other institutions were also among them.

Early in this period Sri A. Chaudhuri, Sri Bikas Kumar Sinha and Sri Bimal Kumar Sinha, all completed their researches under the supervision of Prof. H. K. Nandi and submitted their theses duly to the University of Calcutta for the Ph. D. degree. Sri A. Chaudhuri's thesis was 'Some problems in sampling from a finite population' while those of Sri Bikas Kumar Sinha and Bimal Kumar Sinha were 'Contribution to Comparison of Experiments : Optimum Experiments for Linear Inference' and 'Some Problems of Bayesian Inference', respectively.

Sri P. Mukhopadhyay pursued his studies in sampling theory under Prof. H. K. Nandi and completed his thesis 'Further Studies in Sampling Theory'. He submitted the same to Calcutta University in 1977, and obtained his Ph. D. degree in the same year. Sri Satyabrata Pal and Sri Barun Kumar Dutta also started their research under Prof. H. K. Nandi. Sri Pal investigated on some problems of linear inference and the main-effect plans in the asymmetrical factorial experiments and also studied the nested designs as fractions of asymmetrical factorial. He submitted his thesis 'Some problems of factorial experiments' to the University of Calcutta in 1978, for his Ph. D. degree.

Sri Barun Kumar Dutta continued his research on selection procedures and was investigating some aspects of the principal component analysis. However, Shri Dutta left his research work incomplete and joined Presidency College, Calcutta as a lecturer.

Sri N. K. De and Sri N. K. Patra both began their research work under the guidance of Dr. S. K. Chatterjee. Sri De worked on multivariate non-parametric tests against restricted alternatives and developed rank tests for Randomized Blocks against ordered alternatives by using an extended Union-Intersection Technique and also studied their properties. Sri N. K. De duly completed his investigations into multivariate, non-parametric inference and submitted his Ph. D. Dissertation 'Multivariate Non-parametric Tests against Restricted Alternatives' to the University of Calcutta in 1978.



Sri N. K. Patra has been investigating the construction of multivariate tolerance regions. He has studied the optimum choice of cut-off functions for Tukey-type multivariate tolerance regions and further investigated the construction of asymptotic tolerance regions in the multivariate case, and obtained some results. Sri Partha Chatterjee worked for sometime on the problem of variance component analysis in unbalanced case investigating the properties of certain symmetrical estimators of variance components for unbalanced data, under Prof. S. K. Chatterjee.

Sri N. K. Mandal started his research as a scholar on the study of optimum response surface designs, under Prof. S. K. Chatterjee. He has considered the problem of designing a response surface experiment with a view to locating the optimal point most accurately, and obtained some results in the single and two factors cases.

Sri K. Das also began his research as a scholar under Prof. S. K. Chatterjee on the problem of estimation of variance components for unbalanced classification at the end of 1977. He has been continuing his investigations in the same line and has obtained some further results on marginal maximum likelihood estimates of variance components under the mixed model.

Sri R. Mukherjee completed his research on effectwise orthogonal asymmetric factorial designs under Prof. S. K. Chatterjee. He submitted his thesis entitled 'Asymmetric factorial designs and allied problems' at the end of 1980 and is awaiting for his Ph. D. degree from the University of Calcutta.

Sri U. Bandyopadhyaya started his research on sequential non-parametric tests under Dr. Chatterjee towards the end of this period and attained some results for the two population problem.

Sri R. M. Panda and Sri R. K. Chakraborty carried out their investigations on some aspects of inventory management and prepared a number of papers under Dr. S. P. Mukherjee. Sri B. C. Sasmal studied some problems of reliability estimation from variously censored data assuming K-Erlang failure times in co-operation with Dr. S. P. Mukherjee and has developed rank tests for Randomized Blocks against ordered alternatives by using an extended Union-Intersection Technique and studied their properties.

Sri R. M. Panda continued his investigations on sequential inventory models with supply against on order as a random variable and completed his thesis.





Prof. B. R. Dey continued his research under the guidance of Dr. S. P. Mukherjee and found out parameters in a price adjusting sampling plan by applying decision theory. Later he investigated on a decision-theoretic approach to determination of plan parameters for an attribute single sampling inspection plan. Prof. Dey finalised his thesis and submitted it to the University of Calcutta in 1980. He was awarded Ph.D. degree in early 1981.

Sri R. K. Chakrabarti, later studied some problems of inventory modelling with variable lead time and associated sensitivity problems.

Sri B. C. Sasmal just completed his research and submitted his thesis 'Some Inference Problems Associated with Probability Distributions used in Reliability Theory' to the Calcutta University in December 1980. Sri B. N. Agarwal of the Marwari College, Bhagalpur obtained his Ph.D. degree of the Bhagalpur University under the guidance of Dr. S. P. Mukherjee. Sri L. K. Saran of the same college also has been continuing his research on Reliability Estimation from Stress Strength considerations under Dr. Mukherjee's supervision.

Sri M. Bhattacharyya has joined the department as a Research Scholar from 15th May 1980. He is now working under Dr. S. P. Mukherjee on Mathematical Programming. Sri R. N. Panda of Kalyani University has developed some method of constructing second and third order rotatable design under Dr. B. Adhikary. Sri P. Das of the Kalyani University also studied F-square and related designs under Dr. Adhikary.

#### 4.6 RESEARCH SCHEMES ETC. IN OPERATION

The final report of 'A survey of primary schools in West Bengal and their teachers' of which Prof. P. K. Bose was the director and Sri P. K. Banerjee and Dr. S. P. Mukherjee were the Professors-in-Charge, was published in 1972. It was sponsored by the National Council of Educational Research and Training (NCERT), Govt. of India.

Prof. P. K. Bose, Sri P. K. Banerjee and Dr. S. P. Mukherjee were jointly engaged in conducting a sample survey for studying the cost of elementary education in West Bengal sponsored by NCERT. A preliminary report was submitted to NCERT in 1975. The Department also undertook a survey of Area Skills in the districts of Howrah and Malda. It was sponsored by the NCERT. The Final report on 'Cost of Elementary Education in West Bengal' was published in 1977.

A research scheme 'Graduate Employment & Higher Education—the case of West Bengal' was undertaken by the department during the



session 1977-78. Prof. P. K. Bose was the Director and Dr. S. P. Mukherjee was the joint Director of it. The International Institute for Educational Planning, Paris (UNESCO) sponsored the project. The Department completed it in due time and organised an International Review Workshop on this study in March 1980 in Calcutta. The finalized study report is to be published as a book by UNESCO Press jointly with Wiley Eastern.

#### 4.7 OFF-THE-TRACK SERVICES

The Department helped other departments of this University in the statistical analysis of data as usual. It also collaborated with the Calcutta Statistical Association in the publication of its quarterly journal 'Calcutta Statistical Association Bulletin'.

The Department actively collaborated with the Indian Society for Quality Control in holding an All-India Seminar on Operations Research during October 6-8, 1972. Members of the teaching and non-teaching staff also helped the Society in organising the first All-India Convention on Quality & Reliability at the Indian Institute of Technology, Kharagpur during May 13-14, 1972.

The Department extended its active co-operation to the Indian Association for Productivity, Quality & Reliability (I.A.P.Q.R.) in holding a National Seminar on Inventory Management during October 13-14, 1973 at Jamshedpur. The Department also helped I.A.P.Q.R. in organising training courses in Statistical Quality Control and Operations Research, and in publishing its half-yearly journal-IAPQR Transactions.

The Department at the request of the West Bengal College Enquiry Committee constituted by the Govt. of West Bengal, took up the task of compiling and processing information on academic, administrative and financial aspects of non-government and non-sponsored colleges of West Bengal. Two reports containing information about 18 splinter colleges of seven big colleges in Calcutta and 42 colleges with roll strength less than 500, and two reports on 19 colleges with roll strengths greater than 2000 were prepared. All these reports together with the final recommendations based on them were duly submitted to the Committee.

The Department actively assisted IAPQR in holding a National Seminar on 'Quality Control in Drugs & Pharmaceuticals' during August 13-14, 1976.

The Department also took the initiative in arranging a three-day Seminar on 'Quantitative methods for Decision-Making' sponsored by the U.G.C. was held in the Department during March 27-29, 1978.





The Department extended its active co-operation to IAPQR as usual in organising its two-day conference on 'Productivity in Textile Industry' in Calcutta in collaboration with the Indian Jute Industries Research Association, held in 1980.

#### 4.8 IMPORTANT EVENTS

The Syllabus of the M. A./M. Sc. Part I and Part II course was first revised with the introduction of special groups providing a total of 1000 marks and took effect from the admissions of 1971-1972 session.<sup>1</sup>

The syllabus was again restructured and upgraded with effect from the 1978-79 session. This has been done with a view to making the students better equipped to appreciate the recent developments of the subject. As a result certain new topics like 'Stochastic Process' 'Mathematical Programming' have been included in the syllabus and also greater emphasis has been placed on certain branches like Statistical Inferences, Operations Research etc. Greater scope for choice of advanced-level topics like 'Multivariate Analysis' 'Design of Experiments,' 'Sample Surveys,' and 'Operations Research' as special papers, have been provided.

Prof. H. K. Nandi retired in 1979 leaving behind an outstanding achievement as a successful teacher. Shri P. K. Banerjee's retirement took place in 1980 about one year later.

Sri Ram Bilas Barui, a very sincere member of the non-teaching staff of the Department retired in 1978. He was working from 1st June, 1946.

Two members of the lower Subordinate Staff of the Department Sri Jiban Krishna Samanta and Sri Home Bahadur met their unexpected deaths in 1974 and 1980 respectively. The former died of illness while the latter faced a fatal accident.

The 6th Calcutta University Statistics' Re-Union was held on May 11, 1980, with usual interest and attendance.

#### 4.9 THE DISTINGUISHED VISITORS

Dr. P. V. Sukhatme, formerly Statistical Adviser of the F. A. O., delivered the second S. N. Roy Memorial lecture on 'Protein Malnutrition—its nature and implications' on the 25th July, 1974 in the Department of Statistics, Calcutta University.

Dr. R. E. Barlow, Professor of Operations Research, University of California at Berkely, U. S. A., visited the department on 12th February, 1976 and lectured on 'Fault Tree Analysis.'

1. See appendix 12 for details



Dr. P. K. Sen, Professor of Bio-statistics, University of North Carolina, U. S. A. and formerly a student as well as a lecturer of this Department delivered a course of eight lectures on 'Stochastic Process and its application to problems of Statistical Inference' on July 20 and August 11, 1976.

Prof. Harald Cramer, an outstanding professor and one of the leading international experts in probability theory and stochastic processes visited the department on the 21st February, 1977. His lecture was on 'The Rise and Early Development of the Theory of Stochastic Processes.'

Prof. R. L. Anderson of U. S. A. delivered a lecture on 'Models for estimating optimum level of fertiliser', in the Department of Statistics, on 29th November, 1977.

Prof. Narcel F. Neuts of the Department of Statistics and Computer Science, University of Delaware, Newark, Delaware, U. S. A. visited the department on the 13th January, 1978. The lecture he delivered was on 'Computational Solutions to queueing Problems' on the 13th January, 1978.

Dr. R. Pincus of the Central Institute of Mathematics and Technology, Barlin, GDR gave a talk on 'Goodness of Fit Test Using a Divergency Measure Between Scalar Products' in the Department on February 23, 1979.

Prof. P. K. Sen visited the Department once again during this period to deliver the fourth Prof. S. N. Roy memorial lectures on 'Nonparametric Methods in Growth Curve Model,' on August 21 and 22, 1979.

Prof. Z. Sidak of the Institute of Mathematics, Czechoslovak Academy of Science, Prague, Czechoslovakia, visited the Department on 28th November, 1980 and gave a lecture, the topic of which was 'A refined model for the problem of rakings'.

Dr. Bikas C. Sanyal, a former student of the department and presently the Project Director, IIEP, UNESCO (Paris) visited the department a number of times, in connection with the project 'Graduate Employment and Higher Education' during the period 1978-1980, sponsored by the Institute.

#### 4.10 SOME CONCLUDING REMARKS

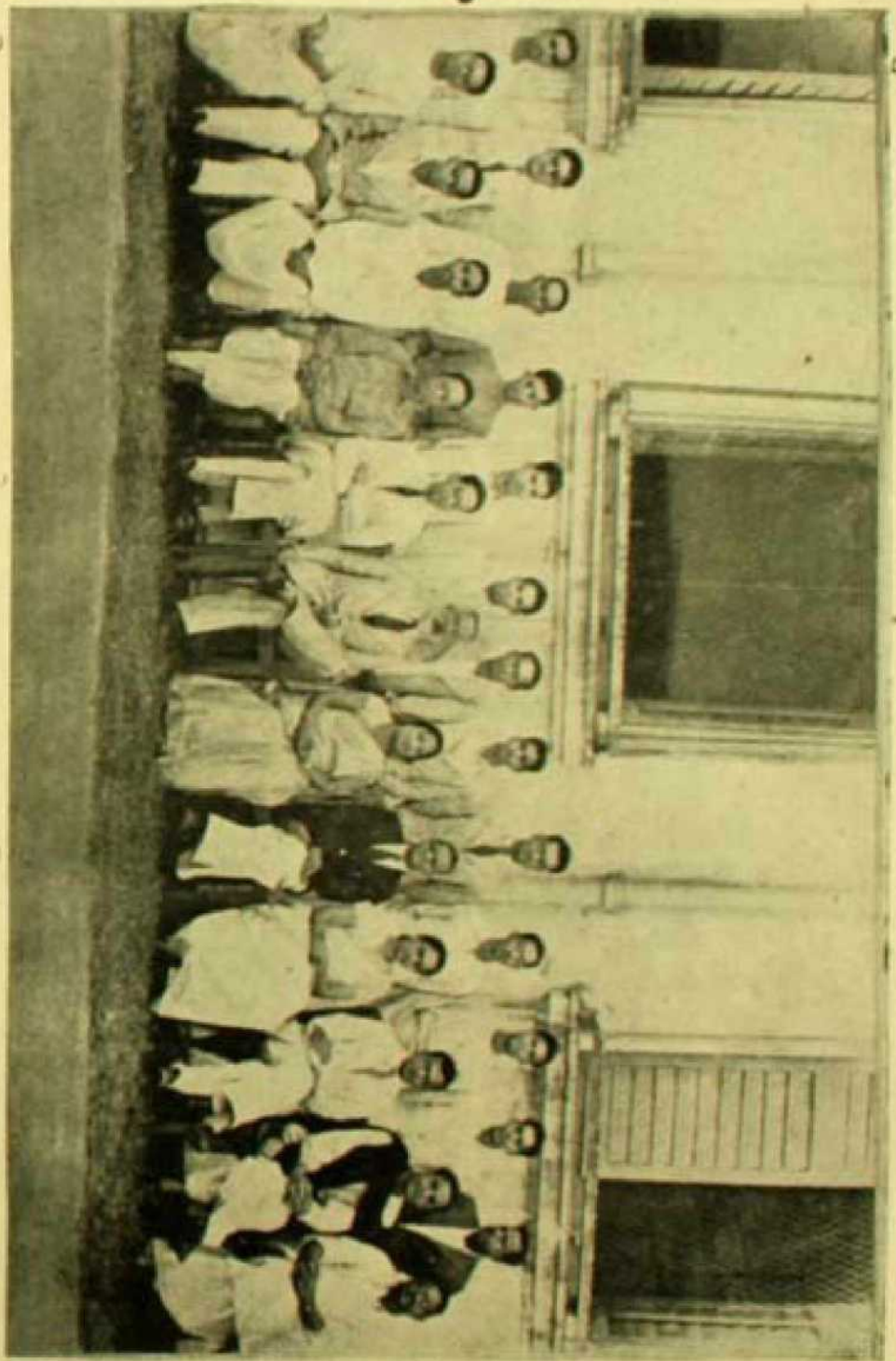
Indeed, the department of statistics, Calcutta University was one of the few centres in the world, in which statistics was being taught in early forties as a separate and distinct discipline.



A RECENT GATHERING :  
A Bigger Group in 1980



EARLY DAYS : A Group in 1945  
including Prof. R. A. Fisher





Fundamental and path-breaking contributions to different branches of decision theory, multivariate analysis, non-parametric methods, sample survey theory, quality control, operations research psychometry etc. have been made by members of the teaching staff and resarch workers of the department.

In India this department pioneered statistical researches and influenced the other universities greatly to introduce statistics to their students, for study and research. The alumni of this department have earned considerable recognition for their educational excellence in different responsible and dignified positions, both in India and abroad.

During the last four decades, the department has produced about 500 statisticians who are efficiently manning various government departments, research institutes, universities and commercial organisations etc. in different parts of this and other countries.

In recent years, however, the department has been facing a great difficulty due to non-availability of an adequate number of sanctioned senior teaching posts. This has made some experienced teachers of the department seek better positions in other institutions.

However, the department on the basis of its activities, steady progress and achievements, seems to have a still more glorious future and wider recognition in spite of some unavoidable constraints.



# Appendix 1

## SOME IMPORTANT AND RELEVANT INFORMATION IN RESPECT OF THE AREA OF THE DEPARTMENT, EQUIPMENTS BELONGING TO IT AND THE DEPARTMENTAL LIBRARY

### I AREA

The Department of Statistics, Calcutta University is housed in the 5th floor of the New Science Building, Ballygunge Science College, 35 Ballygunge Circular Rd., Calcutta-700019 from the 15th March, 1964. At present it covers the entire 5th floor, comprising an area of 20,000 sq. ft. (approx.).

The space allotted for the library amounts to about 4,000 sq. ft. of which actual space available for the reading room, technical purposes, circulation and stack is about 2400 sq. ft. The rest of the total floor space has been utilized as the combined Class-cum-Laboratory rooms (5), Project room (1), Research Scholars' room (1), Teacher's room (7), Office room (1), Machine room (1), and the Store room (1). Some space has also been provided for the library and other activities of two learned associations—The Calcutta Statistical Association and Indian Association for Productivity, Quality and Reliability (2 rooms, in all).

### II THE EQUIPMENTS

The major laboratory and research equipments belonging to the department are as follows : (1) Hand Calculators—60, (2) Punch Machines—4, (3) Verifiers—2, (4) Sorter—1, (5) Electrically operated calculators—4, (6) Electronic calculators—6, (7) Micro-computer—1, (8) Projectors—2.

### III THE DEPARTMENTAL LIBRARY

The Library of the Statistics Department, Calcutta University is a Special Library like the other Departmental Libraries of the University, serving its specialized clientele, mainly the teachers, students and the research scholars of the department. The purchase of the books and journals and the overall technical procedures are controlled and guided by the University Central Library. The day to day management and other administrative work is performed by the Departmental Librarian with the assistance of a sorter. For some time past the services of a member of the nonteaching staff has been made available to the Library. The Departmental Library also entertains its restricted use under the permission of the Head of the Department to the students, teachers and research scholars of the other





departments and on special occasions to eligible specific users. It allows justified interlibrary loans when needed. The holdings of the journals of the library has been duly incorporated in the Regional Union Catalogue of the Scientific Serials : West Bengal, brought out by the Union Catalogue Division of Indian National Scientific Documentation Centre (INSDOC), New Delhi-110012.

It is one of the well-organized Departmental Libraries of the University. The Collection of the books and journals of the library in question, is almost adequate for the requirements of its specialized users. It has been enriched by the several valuable gifts of books and journals from some of its well-wishers and teachers like Sri N. Sarkar, Dr. M. N. Ghosh, Prof. H. K. Nandi, Sri P. K. Banerjee and specially from Prof. P. K. Bose. The entire reprint collection of Prof. S. N. Roy was presented to the Departmental Library after the death of Prof. Roy in U.S.A. The Library records the receipt of these useful publications with due respect to the persons involved in donating them. Two journals viz., 'C. S. A. Bulletin' and 'I. A. P. Q. R. Transactions' are being received complementary. All issues of Sankhya (later only Series A') and some other journals like 'Science & Culture', 'I. S. I. Bulletin', 'Journal of the Indian Statistical Association', 'Journal of the Indian Society of Agricultural Statistics' etc. are being received by the library through Prof. P. K. Bose.

The number of books belonging to the departmental library is nearly 4,500 and that of the bound volumes of journals is about 1500. 20 journals in addition to a number of official and other publications, are currently being received in the library. It also makes available to its users some of important journals and other publications, on request, from the library of the Calcutta Statistical Association which has built-up a very good collection of valuable journals and other publications, specially on mathematics and statistics, mainly received in exchange of their 'Bulletin.'

The library also contains a number of official publications of U. N., F. A. O., I. L. O., C. S. O., Govt. of India Directorate of Econ. & Statistics, Deptt., of Comm. Intelligence & Stat., Labour Bureau, Bureau of Public Enterprises, Bureau of Education, Planning Commission, Directorate of Agriculture, Dept. of Statistics, Transport Research Div., Railways, Deptt. of Econ., Manager of Pubs., Census Pubs., N. C. E. R. T., West Bengal Bureau of Applied Econ. and Stat. and so on.

The library has an well-organised Classified Catalogue on typed cards with necessary (1) the Alphabetical Author-Title entries, (2) the Classified Subject File and (3) the Subject Index. The reprint collection of the library is also of considerable value.

A list of Journals and other serial publications in the collection of the departmental library is given in the following pages for general information.



**THE LIST OF JOURNALS AND OTHER SERIAL PUBLICATIONS  
IN THE COLLECTION OF THE DEPARTMENTAL LIBRARY  
INCLUDING THOSE CURRENTLY RECEIVED\***

<i>Titles</i>	<i>Extent of the holdings</i>	
	<i>From</i>	<i>To</i>
Agricultural Situation in India	Vol. 13 (1948) —	
The American Review	Vol. 3 (1958) —	Vol. 13 (1969)
Annals of Eugenics	Vol. 6 (1953) —	Vol. 17 (1953)
Annals of Mathematical Statistics	Vol. 1 (1930) —	Vol. 43 (1972)
Annals of Statistics	Vol. 1 (1972) —	
Annals of Probability	Vol. 1 (1973) —	
Applied Statistics (J. R. S. S., Sr. C)	Vol. 1 (1952) —	
Biometrika	Vol. 1 (1901) —	
Biometrics (Formerly Biometrics Bulletin)	Vol. 1 (1945) —	Vol. 14 (1958)
The British Journal of Mathematical & Statistical Psychology (Formerly The British Journal of Statistical Psychology)	Vol. 1 (1947) —	Vol. 28 (1975)
Bulletin of the Calcutta Mathematical Society	Vol. 39 (1947) —	Vol. 67 (1975)
Calcutta Municipal Gazette	Vol. 76 (1962) —	
The Calcutta Review	Vol. 100 (1946) —	Vol. 180 (1966)
Calcutta Statistical Association Bulletin	Vol. 1 (1947) —	
Capital	Vol. 119 (1947) —	Vol. 129 (1952)
Econometrica	Vol. 1 (1933) —	
The Economic Weekly	Vol. 15 (1963) —	Vol. 17 (1965)
Economist	Vol. 158 (1950) —	Vol. 190 (1959)
Industrial Quality Control	Vol. 11 (1955) —	Vol. 24 (1967)
IAPQR Transactions: Journal of the Indian Association for Productivity, Quality and Reliability	Vol. 1 (1976) —	
Interfaces	Vol. 8 (1978) —	
ISI Bulletin	Vol. 16 (1964) —	
I. S. Q. C. Bulletin	Vol. 1 (1953-54) —	Vol. 16 (1969)
Journal of Agricultural Science	Vol. 35 (1945) —	Vol. 40 (1950)
Journal of Multivariate Analysis	Vol. 1 (1971) —	
Journal of Quality Technology	Vol. 1 (1969) —	
Journal of the American Statistical Association (Formerly Quarterly Publications of A. S. A.)	Vol. 11 (1908) —	
Journal of the Chartered Insurance Institute	Vol. 34 (1931) —	Vol. 63 (1966)
Journal of the Indian Society of Agricultural Statistics	Vol. 1 (1948) —	
Journal of the Indian Statistical Association	Vol. 1 (1963) —	
Journal of the Institute of Actuaries	Vol. 36 (1901-2) —	Vol. 87 (1961)
Journal of the Institute of Actuaries Student's Society	Vol. 1 (1925) —	Vol. 4 (1932)
Journal of the Insurance Institute of Manchester	1925	1935





Titles	Extent of the holdings	
	From	To
Journal of the Royal Statistical Society, Sr. A. (Formerly J. R. S. S. New Series)	Vol. 88 (1925)	—
Journal of the Royal Statistical Society, Sr. B. (Formerly Supplement to the J. R. S. S.)	Vol. 1 (1934)	—
Management Science: Jour. of the Inst. of Management Sciences	Vol. 25 (1979)	—
Mathematical Reviews	Vol. 29 (1965)	— Vol. 42 (1971)
Mathematics of Operations Research	Vol. 2 (1977)	—
National Sample Survey—General Reports	No. 1 (1950)	— No. 251 (1974)
National Sample Survey—Technical papers	No. 1 (1967)	— No. 52 (1972)
Nature	Vol. 183 (1959)	— Vol. 196 (1962)
Operations Research (ORSA)	Vol. 24 (1976)	—
OR : The Journal of the Operations Research Society (Formerly OR : Operations Research Quarterly)	Vol. 27 (1976)	—
Psychometrika	Vol. 1 (1936)	— Vol. 41 (1976)
Population Studies	Vol. 22 (1968)	—
Records and Statistics	Vol. 1 (1947)	— Vol. 13 (1953)
Reports of the Statistical Application, Research Union of Japanese Scientists and Engineers	Vol. 1 (1953)	—
Review of Economics and Statistics	Vol. 26 (1944)	— Vol. 35 (1953)
Sankhya : The Indian Journal of Statistics (Sr. A,B,C later)	Vol. 1 (1933-34)	—
Science and Culture	Vol. 14 (1948)	—
Statistical Theory and Method Abstracts (Formerly International Journal of Abstracts, Statistical Theory and Methods)	Vol. 1 (1959-60)	—
Technometrics	Vol. 1 (1959)	—
Theory of Probability and its Applications	Vol. 1 (1956)	—
University News	Vol. 4 (1966)	—

\*Only the extent of the holdings of each item in the list is supplied excluding the corresponding missing volumes or issues, if any. The details of the same are readily available in the library on request.



## Appendix 2

### LIST OF PAPERS

(Chronologically arranged under the alphabetical order of surnames of the authors, mainly the teachers and research workers of the department of Statistics, C. U., published in different journals etc., only during the period they were or have been attached to it.)

- ADHIKARI, B., "On the Properties and Construction of Balanced Block Designs with Variable Replications", *C. S. A. Bull.*, Vol. 14 (1965), pp. 36-64.
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- "Some Types of m-Associate PBIB Association Schemes", *C. S. A. Bull.*, Vol. 15 (1966), pp. 47-74.
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- "Some Methods for Constructing PBIB Designs having more than Two Association Classes", *C. S. A. Bull.*, Vol. 18 (1969), pp. 133-162.
- AND NANDI, H. K., "m-Associate Cyclical Association Schemes," in *Essays in Probability and Statistics*, North Carolina University, 1970.
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- BANERJEE, P. K., "Sampling Inspection Procedures", *C. S. A. Bull.*, Vol. 6 (1955), pp. 132-148.
- AND BOSE, P. K., "Foreign Trade of India : 1951-1966", *C. A. S. Bull.*, Vol. 17 (1968), pp. 25-41.
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- BHATTACHARYYA, P. K., "Joint Test for The Mean and Variance of a Normal Population," *C. S. A. Bull.*, Vol. 6 (1955). pp. 73-83.
- , "Comparison of Means of K Normal Populations", *C. S. A. Bull.*, Vol. 7 (1956) pp. 1-66.
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- , "Wilcoxon's Test when both variables are subject to error", *C. S. A. Bull.*, Vol. 11 (1962), pp. 107-108.
- , "On the Role of a Class of a Quantile Tests in Some Multi-Sample Non-parametric Problems", *C. S. A. Bull.*, Vol. 11 (1962), pp. 125-143.
- , "On Studentized Non-parametric Multisample Location Tests", *Ann. of Inst. of Stat. Math* Vol. 14 (1962), pp. 119-131.
- , "On the Properties of U-Statistics when the Observations are not Independent—(1) Estimation of Non-serial Parameters in Some Stationary Stochastic Process", *C. S. A. Bull.* Vol. 12 (1963), pp. 69-92.
- AND BOSE, P. K., "On the Sensitiveness of Z-Score to Non-normality", *C. S. A. Bull.* Vol. 12. (1963), pp. 93-96.
- AND NANDI, H. K., "On the Properties of U-Statistics when the observations are not independent. (II) Unbiased Estimation of the Parameters of a Finite Population", *C. S. A. Bull.*, Vol. 12 (1963), pp. 124-143.
- AND CHATTERJEE, S. K., "Some Non-parametric Tests for the Bivariate Two-sample Location Problem", *C. S. A. Bull.*, Vol. 13 (1963), pp. 18-58.
- , "On the Estimation of Relative Potency in Dilution (direct) Assays by Distribution Free Methods", *Biometrics*, Vol. 19 (1963), pp. 532-552.
- AND CHATTERJEE, S. K., "Some Non-Parametric Test for the Bivariate Two-Sample Association Problem", *C. S. A. Bull.*, Vol. 14 (1965), pp. 14-35.
- SENGUPTA, S., "On the Construction of Non-invariant Balanced Sampling Designs", *C. S. A. Bull.* Vol. 28 (1979), pp. 109-124.
- , "On the Admissibility of the Symmetrized Des Raj Estimator for PPSWPR Samples of Size Two", *C. S. A. Bull.*, Vol. 29 (1980), pp. 35-44.
- , "On the Efficiency of Interpenetrating Subsampling Procedures", *C. S. A. Bull.* Vol. 29 (1980), pp. 173-177.
- , "On Interpenetrating Samples of Unequal Sizes", *Metrika*, (to appear).



- SENGUPTA, S., "A Sampling Scheme to Realize Inclusion Probabilities Exactly Proportional to Size", *Jour. Indian Soc. of Agr. Stat.*, (to appear).
- , "Jack-knifing the Ratio and the Product Estimators in Double sampling", *Metrika*, (to appear).
- SINHA, BIKAS K. AND SINHA, BIMAL K. "Comparison of Relative Efficiency of Some Classes of Designs", *C. S. A. Bull.*, Vol. 18 (1969), pp. 97-112.
- , "Invariant Problems of Linear Inference and Related Designs", *C. S. A. Bull.* Vol. 19 (1970), pp. 103-122.
- , "On the Optimality of Some Designs", *C. S. A. Bull.* Vol. 19 (1970), pp. 1-22.
- , "Invariant Problems of Linear Inference and Related Designs—an Addendum", *C. S. A. Bull.*, Vol. 21 (1972), 51-55.
- , "Comparison of Some Experiments From Sufficiency Consideration," *Ann. Inst. Stat. Math.*, Vol. 25 (1973), pp. 501-520.
- , "On Sampling Schemes to Realize Invariant Preassigned Sets of Inclusion Probabilities of First Two Orders, *C. S. A. Bull.*, Vol. 23 (1974), pp. 45-72.
- AND SINHA, BIMAL K., "Some Problems of Unbiased Sequential Binomial Estimation," *Anu. of Inst. Stat. Math.*, Vol. 27 (1975), pp. 46-58.
- SINHA, BIMAL K., "On the Equivalence of Confidence Sets Based on Bayesian and Non-Bayesian Procedure", *C. S. A. Bull.*, Vol. 19 (1970), pp. 33-40.
- , "A Bayesian Approach to Optimum Allocation in Regression Problems," *C. S. A. Bull.*, Vol. 19 (1970), pp. 45-52.

N.B. : Some accepted papers awaiting their early publication in different journals, are also included in the above list.



## Appendix 3

### LIST OF BOOKS ETC. WRITTEN BY THE TEACHERS OF THE DEPARTMENT

1. Bose, P. K.,  
*Rashi Vijnaner Katha* (in Bengali). Visva-Bharati, 1956.
2. Bose, P. K. & Chaudhuri, S. B.  
On some problem associated with  $D^2$ -statistics and  $p$ -statistics.  
Calcutta : Asia Publishing Hosue, 1967.
3. Bose, P. K. & Mitra, D. N.  
Development of agriculture and increased food production in India.  
Calcutta : The World Press, 1967.
4. Bose, P. K., Benerjee, P. K. & Mukherjee, S. P.  
Engineering Industries in West Bengal—Howrah. Calcutta : The  
World Press, 1970.
5. Bose, P. K., Banerjee, P. K. & Mukherjee, S. P.  
A case study on seven big Colleges in Calcutta their academic,  
administrative and financial affairs. Department of Statistics, Calcutta  
University, 1973.
6. Bose, P. K., Banerjee, P. K. & Mukherjee, S. P.  
Primary schools and their teachers in West Bengal. Calcutta  
University, 1974.
7. Bose, P. K.  
Calcutta University—some problems and their remedies. Calcutta  
University, 1974.
8. Bose, P. K.  
Structural Pattern of education in India. Calcutta University, 19—.  
(a brochure)
9. Bose, P. K.  
Reform of examinations. Calcutta University, 19—. (a brochure)



10. Bose P. K.  
The Role of University In post-experience higher education : a case study on Calcutta University, 1975.
11. Chaudhuri, S. B., Chaudhuri, A. & Das, Biswanath  
*Rashi Vijnaner mool tatwa* (Basic principals of Statistics) : Parts I & II. Calcutta : State Book Board, Govt. of W. B., 1976.  
(A degree pass/hons. level text-book in Bengali. Published under the Centrally sponsored scheme of production of books and literature in regional languages at the University level.)
12. Guhathakurata, B. K., Dasgupta, B. & Adhikari, B.  
*Rashi Vijnaner prayog paddhati* (Methods of applied statistics). Calcutta State Book Board, Govt. of W. B., 1976.  
(A degree pass/hons. level text books in Bengali. Published under the Centrally sponsord scheme of production of books and literature in regional languages at the university level).
13. Bose, P. K.  
Higher education at cross roads. The World Press, 1977.
14. Bose, P. K.  
Uncertain future : an approach to the economic planning of India. Calcutta : Indian Association, 1979.  
(A series of lectures delivered at a symposium held under the auspices of Bharat Sabha).



## Appendix 4

### THE LIST OF THE RECEPIENTS OF D. LITT. & PH.D. DEGREES IN STATISTICS FROM THE UNIVERTITY OF CALCUTTA

<i>Recepients</i>	<i>Year</i>	<i>Title of the Thesis</i>
1. Raj Chandra Bose	1947	Some combinatorial problems of the Design of Experiments.
2. Purnendu Kumar Bose	1949	Parametric relations and statistical tables for the distribution functions of classical and studentised $D^2$ statistics and the use of these distribution functions as graduating population for frequency data
3. Kalisankar Bandyopadhyay	1951	Weighing designs
4. Kailashnath Bhattacharyya	1952	Some combinatorial problems connected with the design of experiments
5. Manindranath Ghosh	1952	Contribution to the theory of non-parametric tests and Wald's decision theory
6. Anukul Chandra Das	1955	On systematic sampling and problems of statistical analysis
7. Mohit Kumar Gangopadhyay	1955	Relaxation method
8. Des Raj	1955	Theory of sampling
9. Jogabrata Roy	1956	On some problems of multivariate analysis
10. Radhagobinda Laha	1957	On characterisation of probability distributions and statistics



<i>Receptants</i>	<i>Year</i>	<i>Title of the Thesis</i>
11. Purnendu Mohan Roy	1957	On some combinatorial problems in the design of experiments
12. Indramohan Chakrabarti	1958	Contributions to the design and analysis of factorial experiments
13. V. S. Varadarajan	1959	Convergence of stochastic process
14. Prodyot Kumar Bhattacharyya	1960	Optimum Properties of some decision procedures
15. R. Ranga Rao	1961	Some problems in probability theory
16. Ranjan Kumar Som	1962	A statistical study of the population in India
17. Sailesbhusan Chaudhuri	1962	Application of statistical methods in psychometric analysis and some associated problems in the construction of statistical tables
18. Shoutir Krishore Chatterjee	1962	Some sequential (two-step and Multi-step) inference procedures with nuisance-parameter free performance in multivariate problems
19. Pranab Kumar Sen	1963	Order statistics and their role in some problems of statistical Inference
20. Manmathanath Bhattacharyya	1963	Distribution-free tests of hypothesis—with reference of two sequences of alternatives.
21. Amitava Ghosal	1963	Contributions to the theory of Dams
22. Jayanta Kumar Ghosh	1963	Optimum properties of some sequential tests of simple and composite hypothesis and other related inference procedure



<i>Recepients</i>	<i>Year</i>	<i>Title of the Thesis</i>
23. Saibal Banerjee	1964	Confidence interval for the two means problem with confidence co-efficient not less than any pre-assigned probability level and its extension to k means
24. Manindra Nath Das	1965	Contributions to design and Analysis of experiments
25. Sambhu Nath Sen	1966	The structure of genetical population
26. Basudev Adhikary	1967	Contribution to incomplete block designs
27. Shyamaprasad Mukherjee	1967	A new approach to the statistical methods for controlling industrial product quality
28. Sukharanjan Chakrabarti	1969	Some univariate and multivariate analysis of variance problems
29. Arijit Chaudhuri	1972	Some problems in sampling from a finite population
30. Bikas Kumar Sinha	1973	Contributions to comparison of experiments : Optimum experiments for linear inference
31. Bimal Kumar Sinha	1973	Some problems of Bayesian inference
32. Srijib Bhusan Bagchi	1975	Sampling plans for reliability demonstration
33. Parimal Mukhopadhyay	1977	Further studies in sampling theory
34. Nanda Kishor De	1978	Multivariate non-parametric Tests against restricted alternatives.
35. Satyabrata Pal	1978	Some problems of factorial Experiments.
36. Bivas Ranjan Dey	1981	Same contributions to sampling inspection plans and their statistical rational.

(N.B. Some of the candidates worked in Institutions other than the Department of Statistics C. U. Only Prof. R. C. Bose was awarded D. Litt. Degree for his Thesis so far).



## Appendix 5

### PROJECTS UNDERTAKEN BY THE DEPARTMENT

<i>Duration</i>	<i>Name of the project</i>	<i>Sponsored by</i>	<i>Conducted by</i>	<i>Report</i>
1. 1954	Undergraduate students in Calcutta : how they live and work—a survey	Calcutta University	K. P. Chattopadhyay, P. K. Bose and A. Chatterjee.	1954
2. 1954	Report on the socio-economic survey of the city of Calcutta, 1954-55	Calcutta University	Economics & Statistics Department, C. U.	1956
3. 1955	The Role of university students in village development work	Calcutta University	A. Chatterjee, T. C. Das and P. K. Bose	1956
4. 1956-57	Measurement of achievement in mathematics, No. I—a statistical study on effectiveness of Board and University examinations in India	Ministry of Education, Govt. of India	Professors-in-charge, P. K. Bose and A. K. Gayen	1960
5. 1959-60	How far gurdians plan education. (First year students residing in Calcutta & suburbs)	Calcutta University	K. P. Chattopadhyay and P. K. Bose	1962
6. 1960-61	Facilities available to students and teachers for study and work in Higher Secondary schools of West Bengal : an educational survey. Report No. 1—Calcutta and 24-Parganas	Calcutta University	P. K. Bose, P. K. Banerjee and S. P. Mukherjee	1961



<i>Duration</i>	<i>Name of the project</i>	<i>Sponsored by</i>	<i>Conducted by</i>	<i>Report</i>
7. 1961-62	Do. Report No. 2— Howrah, Hooghly, Nadia Murshidabad	Calcutta University	P. K. Bose, P. K. Banerjee and S. P. Mukherjee	1962
8. 1963-64	Educational facilities available in the Higher Secondary schools of West Bengal, Tripura, Andaman and Nicobar	N. C. E. R. T., Mins. of Edn., Govt. of India	P. K. Bose, P. K. Banerjee and S. P. Mukherjee	1965
9. 1964-65	Working conditions of Colleges affiliated to the University of Calcutta, during 1962- 63 : an educational survey	Calcutta University	P. K. Bose, P. K. Banerjee and S. P. Mukherjee	1966
10. 1965-67	Engineering Industries of West Bengal— Howrah. (Engineering Industries of Howrah Town)	Calcutta University	P. K. Bose, P. K. Banerjee and S. P. Mukherjee	1970
11. 1966-67	The Existing system of examination and mea- sures for improving upon it—report of the Examination Reforms Committee	Calcutta University	P. K. Bose, Arun Roy, and S. P. Mukherjee	1967
12. 1969	Language for Science & Technology Education	Indian Sc. Congress Associa- tion	P. K. Bose and S. P. Mukherjee	1970
13. 1969-70	Primary Schools & their teachers in West Bengal : a sample survey	N.C.E.R. T., Mins. of Educa- tion, Govt. of India	P. K. Bose, P. K. Banerjee and S. P. Mukherjee	1972
14. 1970-71	Wastage and stagnation in collegiate education	Calcutta University	P. K. Bose and S. P. Mukherjee	1971





<i>Duration</i>	<i>Name of the project</i>	<i>Sponsored by</i>	<i>Conducted by</i>	<i>Report</i>
15. 1973-75	An Enquiry into administrative, academic and financial aspects in non-government and non-sponsored colleges in W. B.	Govt. of West Bengal	P. K. Bose, P. K. Banerjee and S. P. Mukherjee	
16. 1974-77	Cost of Elementary Education in W. B.: a sample survey	N.C.E.R.T., Mins. of Education, Govt. of India.	P. K. Bose, P. K. Banerjee and S. P. Mukherjee	1975
17. 1975-77	Study of Scientific & Technical Manpower Research	Inst. of Applied Manpower for R & D in Eastern India	P. K. Bose and S. P. Mukherjee	
18. 1976-77	Survey of Area Skills	N.C.E.R.T., Mins. of Edu. Govt. of India	P.K. Bose, P.K. Banerjee and S.P. Mukherjee	
19. 1978	Graduate Employment & Higher Education	I.I.E.P. (Paris), UNESCO.	P. K. Bose, and S. P. Mukherjee	1980
20. 1980	Participation, Wastage & Stagnation in Primary Education—the case of Hooghly	Planning Commission	P. K. Bose and S. P. Mukherjee	



# Appendix 6

## MEMBERS OF THE TEACHING STAFF, PAST & PRESENT

<i>Name of the Teacher</i>	<i>Academic Achievement &amp; Membership of Learned Societies etc.</i>	<i>Duration of Teaching in Different Capacities</i>	<i>Topics Taught</i>	<i>Major Research Interest</i>
Adhikari, B.	M. Sc, Ph.D.	Lecturer : 1966—	Algebra, Linear Estimation, Design of Experiments, Econometrics	Design of Exp., Combinatorial Analysis
Banerjee, P. K.	M. Sc.	Lecturer : 1954— Reader : 4.6.64- Retired on 1.3.1980	Sample Survey, Econometrics	Sample Survey, Econometrics
Basu, S.	M. Sc., Ph. D.	Lecturer (Part-time) : 1979—	Stochastic Process	
Bhattacharyya, A.	M. A.	Lecturer (Part-time) : 1941-44	Mathematical Statistics, Math. Analysis, Large Sample Theory	Theory of Stat. Inference
Bhattacharyya, K. N.	M. Sc., D. Phil.	Lecturer (Honorary) : 1958-1971	Construction of Experimental Design	Design of Experiments
Bose, C. (Mrs.)	B.Sc. (Lond.)	Lecturer (Part-time) : 1942-46	Descriptive Statistics	Quality Control, Sample Survey



<i>Name of the Teacher</i>	<i>Academic Achievement &amp; Membership of Learned Societies etc.</i>	<i>Duration of Teaching in Different capacities</i>	<i>Topics Taught</i>	<i>Major Research Interest</i>
Bose, P. K.	M.Sc., Ph.D. F.S.S. (Lond.) F.S.I. (Ind.) F.I.Q.A.(Eng.)	Lecturer : 1942- Reader : 14.8. 1954— Professor : 27.9.62- Pro-V.C. Academic 1969-1976. Head of the Dept. : 1950-31.5.81	Psychometry, Operations Research, Industrial Statistics, Computer Sc., Production Techniques, Statistical Systems	Industrial Stat., Comp. Sc., Psy- chometry, Numerical Analysis, Planning.
Bose, R. C.	M.Sc., D.Litt.	Lecturer : 1941- Head of the Dept. 1945-1949	Mathematical Statistics, Algebra, Design of Experiments, Linear Estima- tion	Combinato- rial Ana- lysis
Chakrabarti, M.		Lecturer : 1945-47.	Descriptive Statistics, Economic Statistics	
Chakrabarti, N. K.		Lecturer : 1944-49.	Economic Statistics	
Chakrabarti, S. R.	M.Sc., Ph.D.	Lecturer : 1968- 1.2.1976	Numerical Analysis, Data Process- ing, Multi- variate Analysis, Sampling Distribu- tion.	Multi- variate Analysis.



<i>Name of the Teacher</i>	<i>Academic Achievement &amp; Membership of Learned Societies etc.</i>	<i>Duration of Teaching in Different capacities</i>	<i>Topics Taught</i>	<i>Major Research Interest</i>
Chaudhuri, A.	M.A., Ph.D.	Lecturer : 1968-1977	Probability, Theory of Sampling from Finite Population	Theory of Sampling
Chaudhuri, S. B.	M.Sc., Ph.D.	Lecturer (Part-time) : 1953	Algebra, Numerical Analysis, Psychometry, Demography, Genetical Statistics	Psychometry
Chaudhuri, T.	M.A., Ph.D.	Lecturer (Part-time) : 1953-1955	Economic Statistics	Econometrics
Chatterjee, S. K.	M.Sc., Ph.D.	Lecturer : 1960- Reader : 2.11.68- Professor : Nov. 1979-	Non-parametric Methods, Multi-variate Analysis, Design of Exp., Mathematical Analysis, Statistical Inference, Sampling Distribution	Multi-variate Analysis, Non-parametric Methods, Design of Experiments
Das, A. C.	M.Sc., Ph.D.	Lecturer (Part-time) : 1948-	Theoretical Statistics, Sampling, Algebra	Theory of Sampling
Das, K.	M.Sc.	Lecturer : Feb., 1980-	Sampling Distributions, Mathematical Programming, Algebra	Analysis of Variance



<i>Name of the Teacher</i>	<i>Academic Achievement &amp; Membership of Learned Societies etc.</i>	<i>Duration of Teaching in Different capacities</i>	<i>Topics Taught</i>	<i>Major Research Interest</i>
Gayen, A. K.	M.A., Ph.D. (Cantab)	Lecturer (Part-time) : 1950-1952	Demography, Psychometry, Quality Control	Statistical Inference, Psychometry
Ghosh, B. N.	M.Sc.	Lecturer : 1943-1958	Theory of Sample Survey	Theory of Sample Survey
Ghosh, J. K.	M.Sc., Ph.D.	Lecturer : 1963-1964	Algebra, Probability	Statistical Inference
Ghosh, M. N.	M.A., Ph.D.	Lecturer : 1944-Oct. 1957	Mathematical Analysis, Large Sample Theory, Economic Statistics	Statistical Inference
Gupta, M. K.	M.Sc., Ph.D.	Lecturer (Part-time) : Nov. 1957-30-11-58	Algebra, Linear Estimation	Estimation Theory
Mahalanobis, P. C.	M.A. (Cantab), F. R. S.	Head of the Deptt. (Honorary) : 1941-1945	Applied Statistics, Model Sampling	Sample Survey, Multi-variate Analysis
Maitra, A. K.	M.A., Ph.D.	Lecturer : 1964-1967	Probability	
Mandal, N. K.	M.Sc.	Lecturer : 1977-	Probability, Linear Models, Design of Exp., Demography	Design of Experiments
Mukherjee, R.	M.Sc.	Lecturer : 17th Nov. 1980-	Design of Exp. Testing of Hypothesis.	Design of Experiments, Applied Stat.





<i>Name of the Teacher</i>	<i>Academic Achievement &amp; Membership of Learned Societies etc.</i>	<i>Duration of Teaching in Different capacities</i>	<i>Topics Taught</i>	<i>Major Research Interest</i>
Mukherjee, S. P.	M.A., Ph.D.	Lecturer : 1964- Reader : 1. 9. 79-	Demography, Operations Research, S. Q. C., Industrial Stat., Large Sample Theo., Stochastic Processes	Operations Research, S. Q. C., Demography, Probability Models
Nag, A. C.	M.Sc., A.C.I.I.	Lecturer (Part-time) : 1952-1960	Demography	Demography
Nair, K. R.	M.A., M.Sc.	Lecturer : 1941-1943	Design of Experiments	Design of Experiments
Nandi, H. K.	M.Sc.	Lecturer : 1944-1959 Reader : 1959- Professor : 17.12.71- Head of the Deptt. 1969-1976, Retired on 1.1.79	Mathematical Analysis, Stat. Inference, Large Sample Theo., Design of Experiments	Statistical Inference, Design of Experiments.
Rao, C. R.	M.A., Ph.D. (Cantab.)	Lecturer (Part-time) 1943-1953	Algebra, Linear Estimation	Design of Experiments, Statistical Inference.
Roy, S. N.	M.Sc.	Lecturer Head of the Deptt. 1949-1950	Multivariate Analysis, Statistical Inference	Multivariate Analysis, Statistical Inference





<i>Name of the Teacher</i>	<i>Academic Achievement &amp; Membership of Learned Societies etc.</i>	<i>Duration of Teaching in Different capacities</i>	<i>Topics Taught</i>	<i>Major Research Interest</i>
Sarkar, S. K.	M.Sc.	Lecturer : 1976- On leave : Nov. 1980	Testing of Hypothesis, Multivariate Analysis	Multivariate Analysis
Seal, K. C.	M.Sc., Ph.D.	Lecturer : (Part-time) 1957 Resigned on : 31.8. 1957	Algebra, Linear Statistical Estimation, Genetics	Inference
Sen, P. K.	M.Sc., Ph.D.	Lecturer : 1962-65	Demography, Bioassay, Numerical Analysis	Non-parametric Inference
Sengupta, Sadashiva	M.Sc.	Lecturer : 1941-43	Economic Statistics	
Sengupta, S.	M.Sc.	Lecturer : 1976-	Sampling Distributions, Estimation, Sample Surveys, Multivariate Analysis	Sample Surveys
Sinha, B. K.	M.Sc. Ph.D.	Lecturer : 1972-75	Comparison of Experiments, Sampling Design	



# Appendix 7

## MEMBERS OF THE NON-TEACHING STAFF WORKING NOW AND BEFORE

(Arranged according to the year of appointment)

<i>Name of the Employee</i>	<i>Academic Qualification</i>	<i>Duration of Service</i>	<i>Designation</i>
Sri Khitish Chandra Sarkar		1st June, 1946-	Mechanic
Sri Nirmalendu Bose		2nd June, 1947- Sept., 1957.	Typist
Sri Pranab Kumar Mitra		8th Feb., 1955-	Office Asst.
Sri Shyamalendu Ganguly	M. Sc.	19th May, 1958-	Laboratory Asst.
Sri Pranabanada Jana	B.Sc., M. Lib. Sc.	2nd Feb., 1962-	Deptt. Librarian
Sri Pabitra Kumar Mullick	M. Com.	1st July, 1966-	Operator
Sri Debaprasad Bhatta- charyya	B. Com., B. Lib. Sc.	13th Feb., 1971-	Computer
Sri Timir Roy Choudhury	B.S.c, B. Lib. Sc.	18th Feb., 1971-1975	Computer
Sri Priya Ranjan Lahiri	B. Sc.,	1st July, 1976-	Computer
Sri Ram Bilas Barui		1st June, 1943- 28th Feb., 1979	Skilled Bearer
Sri Indra Bhusan Ganguly		21st Nov., 1951-	Sorter
Sri Jiban Kumar Samanta		1st July, 1959- May, 1974.	Duftry
Sri Surya Kumar Shee		1st July, 1965-	Bearer
Sri Baijnath Prasad		1st July, 1965-	Farash
Sri Santosh Kumar Shee		13th Aug., 1974-	Peon
Sri Home Bahadur		31st Aug., 1979- 1st March, 1978	Bearer (Temporary)

N. B. : It must be mentioned that it was not possible to enumerate here the names of quite a large number of persons who worked or have been working as temporary hands in various capacities in different projects undertaken by the department at different times. The names of the L. S. Staff who worked in leave vacancies also could not be incorporated in the above list.



## Appendix 8

### THE LIST OF STUDENTS ADMITTED

#### 1941

- |                             |                                   |
|-----------------------------|-----------------------------------|
| 1. Prosad Kumar Banerjee    | 8. Bimalendu De                   |
| 2. Kamal Chandra Banerjee   | 9. Manindra Nath Ghosh (Deceased) |
| 3. Raghunandan P. Bhargava  | 10. Utpal Chandra Guha            |
| 4. N. Biswas                | 11. A. K. Mukherjee               |
| 5. Manindra Nath Bose       | 12. H. K. Nandi                   |
| 6. Nirmal Kumar Chakraborty | 13. C. R. Rao                     |
| 7. Prasanta Chowdhury       |                                   |

#### 1942

- |                           |                        |
|---------------------------|------------------------|
| 1. Durgadas Basu          | 6. Kiran Chandra Gupta |
| 2. Prafulla Kumar Bhowmik | 7. J. P. Pandey        |
| 3. Tarapada Choudhury     | 8. K. P. Purokayastha  |
| 4. K. A. Dandekar         | 9. Anadi Ranjan Roy    |
| 5. V. M. Dandekar         | 10. P. R. Sengupta     |

#### 1943

- |                               |                             |
|-------------------------------|-----------------------------|
| 1. Amarendra Chandra Basu     | 8. N. C. Dutta              |
| 2. Phanindra Nath Chakravarty | 9. Amalendu Narayan Ganguli |
| 3. Rabindra Mohan Chatterjee  | 10. Hemendra Nath Majumder  |
| 4. P. Chowdhury               | 11. Suhrit Kumar Nag        |
| 5. Barindra Nath Das          | 12. D. K. Raman             |
| 6. Manindra Nath Das          | 13. Anil Kumar Sinha        |
| 7. R. N. De                   |                             |

#### 1944

- |                                  |                        |
|----------------------------------|------------------------|
| 1. Kailash Nath Bhattacharyya    | 8. Rabiul Hassan       |
| 2. Anukul Chandra Das (Deceased) | 9. Kamaluzzaman        |
| 3. Des Raj                       | 10. Lakshminarayana    |
| 4. Fassihuddin                   | 11. Maniruzsaman       |
| 5. Mohit Kumar Ganguly           | 12. M. K. Nag          |
| 6. Nikunja Behari Ganguly        | 13. Purnendu Mohan Roy |
| 7. A. K. Gupta                   | 14. Mahabir Prosad Roy |



**1945**

- |                              |                        |
|------------------------------|------------------------|
| 1. Biswanath Prosad Adhikary | 9. Ajit Majumder       |
| 2. K. Bhattacharyya          | 10. P. S. Menon        |
| 3. Hara Prosad Biswas        | 11. S. S. Nair         |
| 4. S. K. Ghatak              | 12. V. Patel           |
| 5. M. S. Ghokhale            | 13. Ramaprosad Saha    |
| 6. S. K. Goswami             | 14. J. N. Sarma        |
| 7. Abdul Hakim               | 15. Sailen Sen         |
| 8. P. N. Kaul                | 16. Dwarka Viswanathan |

**1946**

- |  |  |
|--|--|
| 1. Anil Kumar Bhattacharya                 | 9. Abdul Hossain                       |
| 2. Debabrata Chakraborty                   | 10. Sudhangshu Kumar Majumder          |
| 3. Prasanta Kumar Chatterjee<br>(Deceased) | 11. Dinesh Chandra Mista<br>(Deceased) |
| 4. Samarendra Nath Dhar                    | 12. Abdur Rahim                        |
| 5. Damodar Dutta                           | 13. N. A. Rahaman                      |
| 6. Amitava Dutta                           | 14. C. K. Rao                          |
| 7. Amitava Ghosal                          | 15. Sambhu Sen                         |
| 8. Sushil Gupta                            | 16. Ranjan Kumar Som                   |

**1947**

- |                                |                              |
|--------------------------------|------------------------------|
| 1. Tapas Bagchi                | 11. Haragauri Narayan Gupta  |
| 2. Saibal Kumar Banerjee       | 12. S. N. Lahiri             |
| 3. Manmatha Nath Bhattacharyya | 13. Kulendra Nath Majumdar   |
| 4. Ajoy Kumar Bose             | 14. Kalyan Kumar Mukherjee   |
| 5. S. B. Chowdhury             | 15. Rajendra Nath Roy        |
| 6. Prabir Das                  | 16. Naresh Chandra Samajpati |
| 7. Shivendra Das Gupta         | 17. Kiron Chandra Seal       |
| 8. Keshab Chandra Dhar         | 18. H. N. Singh              |
| 9. Nitai Chandra Dutta         | 19. Birendra Nath Sarkar     |
| 10. Lalit Kumar Ghosh          |                              |

**1948**

- |                             |                         |
|-----------------------------|-------------------------|
| 1. Anil Kumar Bose          | 7. Kantis Chandra Maiti |
| 2. Indra Mohan Chakravorty  | 8. Monoranjan Pal       |
| 3. Kamal Chandra Chanda     | 9. Amiya Kumar Panda    |
| 4. Shibnath Chaturvedi      | 10. A. Raghavendra Rao  |
| 5. Bhupendra Nath Chowdhury | 11. Jogabrata Roy       |
| 6. Ajit Kumar Dasgupta      | 12. Subir Sen           |



13. Amiya Kumar Dutta
14. V. P. Godambe
15. Ajit Kumar Halder

16. Dipankar Sarkar
17. Upendra Chandra Talukdar
18. Viresh Kumar Tyagi

**1949**

1. Shaukat Abbas
2. Bodhendu Bikash Biswas
3. Santi Kumar Bose
4. Dipak Chakravorty
5. Nani Gopal Das
6. Nripendra Dasgupta
7. Chittaranjan De
8. Keshab Chandra Dutta

9. Dilip Kumar Ghosh
10. Rudrendra Kumar Ghosh
11. Mohanlal Gupta
12. Brojendra Kumar Guha Thakurta
13. Radha Govinda Laha
14. Sujit Kumar Mitra
15. Bhanudev Sen
16. Prasun Sengupta

**1950**

1. Ashok Kumar Banerjee
2. Prithwinath Bhargava
3. Ajit Kumar Bhattacharyya
4. Ashish Kumar Chakravorty
5. Madhusudan Chakravorty
6. Haramohan Das
7. Sadhu Singh Dheendsa
8. Benoy Kumar Ghosh

9. Manindra Nath Ghosh
10. Rajendralal Ghosh
11. Keshab Chandra Majumdar
12. Samarendra Nath Mitra
13. Prabhash Kumar Mukherjee
14. Arun Kumar Roychoudhuri
15. Deva Prosad Roy
16. Moni Lal Roy

**1951**

1. Prafulla Chandra Banerjee
2. Sanat Kumar Banerjee
3. Pranob Kumar Banerjee
4. Ajit Kumar Bhattacharya
5. Pradyot Kumar Bhattacharyya
6. Parthamohan Chakravorty
7. Banamali Das
8. Saurindra Nath Das

9. Ajoy Kumar De
10. Ashutosh Ghosh Majumdar
11. Prabir Kumar Ghosh
12. Narayan Chandra Giri
13. Atindra Mohan Gun
14. Bhabani Prasad Kar
15. Arabinda Kundu
16. Anish Kumar Maitra

**1952**

1. Banadev Banerjee
2. Arun Kanti Bhattacharya
3. Nikhilesh Bhattacharya
4. Lalit Kishore Burman
5. Debidas Chakravorty
6. Saurindra Kumar Chakravorty
7. Subimal Chowdhuri

8. Debabrata Ghosh
9. Samarendra Nath Guha
10. M. K. Gupta
11. Probhat Kumar Hazra
12. Phanibhusan Khan
13. Hiralal Mukherjee
14. Amar Sundar Roy



15. Ramendra Nath Das
16. B. Dasgupta
17. Netai Chandra De

18. Uma Charan Roy
19. Arun Prokash Som

### 1953

1. Pranab Kumar Jana
2. Bibhuti Bhusan Bhattacharyya
3. Dilip Kumar Bagchi
4. Sachchidananda Dutta Roy
5. Samir Kumar Ghosh
6. Monoranjan Dutta
7. Suprakash Chatterjee
8. Chittaranjan Malakar
9. Soma Chandra Dasgupta

10. Mrinal Kanti Dutta Chowdhuri
11. Sukhendranath Roy
12. Mankumar Chakraborty
13. Banku Behari Saha
14. Chandra Sekhar Dani
15. Dwijendra Kumar Roychowdhury
16. G. D. Koyal (deceased)
17. Suresh Kr. Ghosh
18. Bijon Kumar Dutta Roy

### 1954

1. Mainak Majumdar
2. Nideahoo Ram Mehra
3. Prithwish Chandra Chowdhuri
4. Sukhendu Narayan Nath
5. Nanak Chand
6. Mukul Bikas Maity
7. S. K. Chatterjee
8. Ashim Kumar Sen
9. Dilip Kumar Guha
10. Banku Behari Saha

11. Garnepudi Venkataswarlu
12. Ranjit Kumar Ghosh
13. Santosh Kumar Rudra
14. Ramesh Chandra Chanda
15. Gunadhar Sahu
16. Sudhindra Nath Roy
17. Puskar Dutta
18. Ranjit Sinha
19. Biswajit Ghosh
20. Motilal Tikku

### 1955

1. Krishnapada Das
2. Pradosh Ukil
3. N. Gopalsundaran
4. Madan Lal Das
5. Sailendra M. Sannyasi
6. Jotish Chandra Maity
7. Ranjit Kumar Mukherjee
8. Satyabrata Gupta
9. Niladrinath Majumdar
10. Nira Basack

11. Prithwis Dasgupta
12. Sibesh Niyogi
13. Bhaskar Kumar Ghosh
14. Binode Behari
15. Kiron Kumar Mitra
16. Saktipada Ghosh
17. Pranab Kumar Sen
18. Hironmoy Majumdar
19. Pradip Kumar Mitra
20. Dilip Kumar Bhattacharyya
21. Kalpana Roy Chowdhury



**1956**

- |                                |                                 |
|--------------------------------|---------------------------------|
| 1. Ashutosh Sen                | 11. Kakaram Pandit              |
| 2. Arun Kumar Dey              | 12. Sati Chatterjee             |
| 3. Bijan Kumar Dutta           | 13. Rabindra Nath Bhattacharyya |
| 4. Asoke Kumar Chatterjee      | 14. Pankaj Kumar Ghosh          |
| 5. Sailendra Kumar Chakravorty | 15. Jayanta Kumar Ghosh         |
| 6. Chinmoy Koley               | 16. Netaidas Ghosal             |
| 7. Debika Roy                  | 17. Asit Prakas Basu            |
| 8. Jitendriya Sarangi          | 18. Krishna Chandra Pati        |
| 9. Keshab Chakrabarty          | 19. Gopal Chandra Sarkar        |
| 10. Bidur Dutta                |                                 |

**1957**

- |                              |                               |
|------------------------------|-------------------------------|
| 1. Subrata Kumar Bose        | 11. Ramanath Samaddar         |
| 2. Bikash Chandra Sanyal     | 12. Manas Kumar Chatterjee    |
| 3. Bishnu Sadhan Koley       | 13. Sukha Ranjan Dey          |
| 4. Ajit Kumar Sen            | 14. Bibhas Ranjan Dey         |
| 5. Md. Ashanulla             | 15. Arunendu Sen              |
| 6. Balaram Das               | 16. Sanjib Bhusan Ghatak      |
| 7. Chandan Kumar Mustafi     | 17. Biswanath Chowdhury       |
| 8. Taral Kumar Dutta         | 18. Umakanta Giri             |
| 9. Monoranjan Betal          | 19. Dilip Kumar Bhattacharyya |
| 10. Mahesh Chandra Mukherjee |                               |

**1958**

- |                             |                                |
|-----------------------------|--------------------------------|
| 1. Saibal Kumar Mitra       | 12. Shyama Prasad Mukherjee    |
| 2. Sivaprosad Bhattacharyya | 13. Manish Bhattacharjee       |
| 3. Pathik Kumar Kundu       | 14. Samprit Chatterjee         |
| 4. Shambhudas Bhattacharyya | 15. Anish Kumar Majumdar       |
| 5. Mrityunjay Samanta       | 16. Suvashis Banerjee          |
| 6. Ashim Chowdhury          | 17. Sushil Kumar Bhattacharyya |
| 7. Dhurjati Prasad Roy      | 18. Ananta Kumar Maikap        |
| 8. Aloke Kumar Banerjee     | 19. Benoy Kumar Dutta          |
| 9. Rudrakanta Sinha         | 20. Gouri Kanta Bhattacharyya  |
| 10. Prasanta Kumar Giri     | 21. Kamal Kanti Basu Roy       |
| 11. Amitava Lahiri          | 22. Tarun Prasad Basu          |

**1959**

- |                            |                        |
|----------------------------|------------------------|
| 1. Madhu Sudan Maulik      | 4. Debabrata Karforma  |
| 2. Saumendranath Mukherjee | 5. Monoj Kumar Basu    |
| 3. Utpal Dasgupta          | 6. Radha Perumal Naidu |



- |                              |                           |
|------------------------------|---------------------------|
| 7. Arun Kumar Mukherjee      | 13. Md. Ziauddin          |
| 8. Arijit Chowdhuri          | 14. Bhushan Lal Khazanchi |
| 9. Prasanta Kumar Sadhu Khan | 15. Rabindra Nath Mondal  |
| 10. Nanda Kishore De         | 16. Archana Sirkar        |
| 11. Birendrakishore Nag      | 17. Kalyan Kumar Dutta    |
| 12. Anish Mukherjee          | 18. Rabindra Nath Roy     |

#### 1960

- |                            |                               |
|----------------------------|-------------------------------|
| 1. Tapash Ranjan Bhowmick  | 12. Aloknath Bhattacharyya    |
| 2. Prithwis Kumar Kar      | 13. Debabrata Roy             |
| 3. Salil Kumar Dutta       | 14. Animesh Chatterjee        |
| 4. Jyotirmoy Dutta         | 15. Shyamali Dam              |
| 5. Ajoy Kumar Dhar         | 16. Rajat Gupta               |
| 6. Harendranath Sur        | 17. Gopal Chandra Majumdar    |
| 7. Someswar Nath Chaudhury | 18. Abdur Rahaman             |
| 8. Sunil Bhattacharyya     | 19. Basudeb Adhikary          |
| 9. Asokendra Nath Poddar   | 20. Puspa Lal Joshi           |
| 10. Adhir Kumar Basu       | 21. Rajat Kanti Bhattacharyya |
| 11. Dipankar Basu          |                               |

#### 1961

- |                               |                           |
|-------------------------------|---------------------------|
| 1. Arun Kumar Dutta           | 12. Mukul Ranjan Saha     |
| 2. Subodhan Sarkar            | 13. Ashutosh Chakrabarti  |
| 3. Chandan Kumar Basu         | 14. Pratul Mukherjee      |
| 4. Ramgobinda Sarangi         | 15. Pijush Dasgupta       |
| 5. Aniruddha Sengupta         | 16. Kalyan Chakrabarty    |
| 6. Jagannath Saha Bhowmick    | 17. Dhruba Kumar Dutta    |
| 7. Nirmal Kanti Roy           | 18. Md. Mukhtar Ali       |
| 8. Arun Kumar Chatterjee      | 19. Taradas Bhattacharjee |
| 9. Manju Chakrabarty          | 20. Bhubaneswar Mukherjee |
| 10. Brojeswar Chakrabarty     | 21. Dilip Kumar Sarkar    |
| 11. Dhirendranath Chakrabarty |                           |

#### 1962

- |                           |                              |
|---------------------------|------------------------------|
| 1. Basudev Dutta          | 9. Sudarsan Senapati         |
| 2. Malay Ghosh            | 10. Tusharkanti Mitra        |
| 3. Dipak Chakrabarty      | 11. Tapas Kumar Banerjee     |
| 4. Samarjit Kumar Mitra   | 12. Arunabha Sinha           |
| 5. Pradyot Kumar Bhandari | 13. Satindra Nath Kundu      |
| 6. Alok Kumar Mukherjee   | 14. Jnanabrata Roy           |
| 7. Utpalendu Dutta        | 15. Debaprosad Bhattacharyya |
| 8. Sitansu Mohan Chaki    | 16. Sushil Kumar Srestha     |



**1963**

- |                               |                               |
|-------------------------------|-------------------------------|
| 1. Samarendra Mohan Banerjee  | 14. Pradyot Nath Dasgupta     |
| 2. Ranjan Kumar Bhattacharyya | 15. Hemanta Mukherjee         |
| 3. Chandrasekhar Das          | 16. Tapan Kumar Dasgupta      |
| 4. Kalyan Dutta               | 17. Bimal Chandra Majumdar    |
| 5. Parimal Kanti Pal          | 18. Sunil Chandra Sanyal      |
| 6. Ashim Sankar Nag           | 19. Arabinda Hor              |
| 7. Jayanta Kumar Das          | 20. Buddhadev Bhattacharyya   |
| 8. Paramesh Prasanna Dey      | 21. Ashim Kumar Bhattacharyya |
| 9. Prasanta Kumar Das         | 22. P. Sen                    |
| 10. Parimal Mukherjee         | 23. Nirjhar Neogi             |
| 11. Biswanath Das             | 24. Manas Chakrabarti         |
| 12. Apurba Narayan Ghosh      | 25. Sipra Mukherjee           |
| 13. Aloke Nath Chawdhury      | 26. Sukumar Dutta             |

**1964**

- |                             |                            |
|-----------------------------|----------------------------|
| 1. Mrinal Mukherjee         | 13. Keya Majumdar          |
| 2. Sulabh Kumar Mukherjee   | 14. Udayan Dasgupta        |
| 3. Ajit Kumar Kumar         | 15. Anupam Biswas          |
| 4. Buddhadev Ghosh Dastidar | 16. Bibek Ranjan Jana      |
| 5. Subrata Basu             | 17. A. N. Mazhar Ali       |
| 6. Alipta Kumar Pal         | 18. Damodar Saha           |
| 7. Sujit Kumar Basu         | 19. Prasanta Kumar Saha    |
| 8. Asoke Chakrabarty        | 20. Ranjan Pal Chowdhury   |
| 9. Himadri Kumar Roy        | 21. Pranab Kumar Saha      |
| 10. Satyabrata Pal          | 22. Jayanta Kumar Banerjee |
| 11. Reba Rani Dutta         | 23. Nishith Kumar Patra    |
| 12. Rita Basu               | 24. Sunil Chandra Sanyal   |

**1965**

- |                           |                             |
|---------------------------|-----------------------------|
| 1. Radhamadhab Panda      | 11. Samar Ranjan Pal        |
| 2. Bimal Kumar Sinha      | 12. Prabhat Ranjan Das      |
| 3. Bikash Kumar Sinha     | 13. Bisakha Gupta Ray       |
| 4. Subrata Chatterjee     | 14. Shyamal Kumar Chaudhury |
| 5. Gour Mohan Saha        | 15. Radhakrishna Biswas     |
| 6. Kamal Kanta Ghosal     | 16. Rashbehari Biswas       |
| 7. Pinaki Ranjan Saha     | 17. Amalesh Tripathi        |
| 8. Santi Ranjan Pal       | 18. Jayanti Ghosh           |
| 9. Sunirmal Sen           | 19. Shyamali Ghosh          |
| 10. Shantanu Maulik Gupta | 20. Ashok Kumar Hati        |



**1966**

- |                               |                            |
|-------------------------------|----------------------------|
| 1. Asis Kumar Mukherjee       | 11. Swapan Kumar Das       |
| 2. Mita Bhattacharyya         | 12. R. Jagannathan         |
| 3. Arundhati Mukherjee        | 13. Swapan Kumar Mukherjee |
| 4. Chanchal Kumar Banerjee    | 14. Susmita Sarkar         |
| 5. Sanat Kumar Mandal         | 15. Bijan Kumar Kundu      |
| 6. Himansu Sekhar Chakrabarty | 16. Pinaki Ghosh Dastidar  |
| 7. Kali Kinkar Bose           | 17. Sachindra Nath Datta   |
| 8. Manotosh Chakrabarty       | 18. Krishnapada Sarkar     |
| 9. Ranajit Chakrabarty        | 19. Soumyendra Nath Das    |
| 10. Srijib Bhusan Bagchi      |                            |

**1967**

- |                       |                           |
|-----------------------|---------------------------|
| 1. Prabir Kumar Ghosh | 8. Subhas Chandra Ganguly |
| 2. Dilip Kumar Ghosh  | 9. Sourangshu Kumar Roy   |
| 3. Swaraj Kumar Nath  | 10. Asit Baran Giri       |
| 4. Sankar Lal Set     | 11. Haren Dwibedi         |
| 5. Debsankar Gupta    | 12. Asoke Chakrabarty     |
| 6. Kalyan Kumar Roy   | 13. Amal Chakrabarty      |
| 7. Sipra Sengupta     | 14. Bimalendu Kundu       |

**1968**

- |                              |                              |
|------------------------------|------------------------------|
| 1. Subir Ghosh               | 12. Pijush Kanti Bardhan     |
| 2. Vaskar Saha               | 13. Tapas Kumar Mukherjee    |
| 3. Partha Sarathi Sen        | 14. Sujit Kumar Roychowdhury |
| 4. Nirmal Kumar Chatterjee   | 15. Srimanta Kumar Jana      |
| 5. Barun Kumar Dutta         | 16. Prasanta Kumar Roy       |
| 6. Dipak Das                 | 17. Kishori Mohan Jana       |
| 7. Praphullit Lama           | 18. Sunil Kumar Pal          |
| 8. Kashinath Bose            | 19. Sadhan Samar Maity       |
| 9. Arup Kumar Saha           | 20. Arafat Ali Molla         |
| 10. Shibaji Chakrabarty      | 21. Shibsankar Roy           |
| 11. Bansibadan Mukhopadhyaya |                              |

**1969**

- |                            |                              |
|----------------------------|------------------------------|
| 1. Priyadarshini Majumdar  | 7. Satyajit Kumar Sen        |
| 2. Dipti Roy               | 8. Aparna Sarkar             |
| 3. Jayasree Saha Roy       | 9. Hridayansu Sekhar Sen     |
| 4. Maitreyi Mukherjee      | 10. Subir Basu               |
| 5. Asis Kumar Banik        | 11. Ramaprasad Bhattacharyya |
| 6. Niharendu Bhattacharyya | 12. Parthasarathi Chatterjee |



**1970**

- |                           |                               |
|---------------------------|-------------------------------|
| 1. Suchitra Ghosh         | 12. Asish Kumar Sen           |
| 2. Nripendranath Saha     | 13. Santosh Deb               |
| 3. Dilip Roy              | 14. Rajendranath Panda        |
| 4. Dibyendranath Majumdar | 15. Achintya Priya Purakait   |
| 5. Swapan Kumar Das       | 16. Sadhanananda Jana         |
| 6. Md. Ziauddin           | 17. Madhab Chandra Chatterjee |
| 7. Bhaskar Dasgupta       | 18. Salil Ranjan Das          |
| 8. Ila Ghatak             | 19. Tapan Kumar Dasgupta      |
| 9. Anjana Mitra           | 20. Ramprosad Mukherjee       |
| 10. Motilal Bhattacharyya | 21. Nirmal Kumar Basu         |
| 11. Raghunath Arnab       |                               |

**1971**

- |                         |                       |
|-------------------------|-----------------------|
| 1. Ruby Mitra           | 7. Kanupriya Goswami  |
| 2. Sushil Kumar Paul    | 8. Satyabrata Saha    |
| 3. Ashish Sengupta      | 9. Mita Bhattacharyya |
| 4. Sankar Bhattacharyya | 10. Juthika Majumdar  |
| 5. Premadhish Das       | 11. Jhulan Kumar Kar  |
| 6. Amit Kumar Ghosh     | 12. Amit Sengupta     |

**1972**

- |                         |                            |
|-------------------------|----------------------------|
| 1. Dalia Basak          | 8. Mihir Kumar Banerjee    |
| 2. Dipankar Ghosh       | 9. Chittaranjan Nayak      |
| 3. Dhruba Chakrabarty   | 10. Sanat Kumar Sarkar     |
| 4. Mita Banerjee        | 11. Samindra Nath Sengupta |
| 5. Nripesh Kumar Mondal | 12. Ranjit Kumar Mitra     |
| 6. Ratan Dasgupta       | 13. Jaydeb Dutta           |
| 7. Gautam Chowdhury     | 14. Ambujaksha Mahanti     |

**1973**

- |                           |                         |
|---------------------------|-------------------------|
| 1. Kalyan Das             | 9. Arun Kumar Adhikari  |
| 2. Biswajit Dey           | 10. Ranjit Kumar Kandar |
| 3. Uttam Banerjee         | 11. Pankaj Kanti Bhadra |
| 4. Snehanu Sengupta       | 12. Prodyot Kumar Nath  |
| 5. Debasish Bhattacharyya | 13. Sanjoy Kumar Mitra  |
| 6. Anupam Guha Thakurta   | 14. Tapas Kumar Mondal  |
| 7. Siddhartha Kumar Ghosh | 15. Deb Kumar Banerjee  |
| 8. Subrata Kumar Das      |                         |



**1974**

- |                        |                           |
|------------------------|---------------------------|
| 1. Bimal Kumar Saha    | 8. Ranjit Kumar Biswas    |
| 2. Prasun Chakrabarty  | 9. Ashit Kumar Kanrar     |
| 3. Shakuntala Sarkar   | 10. Ranjan Roy            |
| 4. Nimai Kumar Chandra | 11. Dipankar Chatterjee   |
| 5. Bimal Kumar Giri    | 13. Ashim Roy Chowdhury   |
| 6. Arup Roy            | 14. Asoke Kumar Mukherjee |
| 7. Partha Majumdar     |                           |

**1975**

- |                         |                         |
|-------------------------|-------------------------|
| 1. Swapan Banerjee      | 12. Rahul Mukherjee     |
| 2. Swati Dutta          | 13. Prosanta Kumar Basu |
| 3. Tapas Kumar Dutta    | 14. Dipak Kumar Chandra |
| 4. Byomkesh Manna       | 15. Raj Gautam Mitra    |
| 5. Sekhar Bhattacharyya | 16. Dipak Ranjan Saha   |
| 6. Samir Ranjan Sarkar  | 17. Nirvan Kumar Das    |
| 7. Niharendu Kumar Saha | 18. Sudip Roy Chowdhury |
| 8. Nilachal Roy         | 19. Kamal Chowdhury     |
| 9. Prasanta Dey         | 20. Asoke Chatterjee    |
| 10. Debashis Guha       | 21. Santanu Mondal      |
| 11. Anupam Basu         |                         |

**1976**

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|--------------------------|----------------------------|
| 1. Bimal Chandra Roy     | 12. Ramkrishna Samanta     |
| 2. Samarendra Nath Pal   | 13. Malay Bhattacharyya    |
| 3. Gautam Seth           | 14. Asit Panda             |
| 4. Manik De              | 15. Lakshmi Kanta Dutta    |
| 5. Debashis Chowdhury    | 16. Siladitya Chowdhury    |
| 6. Sudip Chowdhury       | 17. Dipankar Chakrabarty   |
| 7. Saswati Roy Chowdhury | 18. Aditya Chatterjee      |
| 8. Sunil Chakrabarty     | 19. Amar Sarkar            |
| 9. Debika Ganguly        | 20. Pradip Kumar Mahapatra |
| 10. Kakali Mookherjee    | 21. Jyoti Ranjn Majumdar   |
| 11. Achintya Srimany     |                            |

**1977**

- |                           |                           |
|---------------------------|---------------------------|
| 1. Sreeja Guha            | 7. Manish Pal             |
| 2. Satyabrata Chakrabarty | 8. Sudip Maity            |
| 3. Subrata Dhar           | 9. Biplab Roy Chowdhury   |
| 4. Tanmay Ghosal          | 10. Manisankar Mukherjee  |
| 5. Dipankar Sinha         | 11. Chandranath Mukherjee |
| 6. Madhabendra Mallik     | 12. Kashi Nath Dutta      |



**1978**

- |                          |                         |
|--------------------------|-------------------------|
| 1. Arijit Banerjee       | 11. Tarun Kanti Basu    |
| 2. Partha Sarathi Mitra  | 12. Dilip Kumar Sahu    |
| 3. Mausumi Sen           | 13. Debabrata Mukherjee |
| 4. Gaytri Bhattacharyya  | 14. Sudip Kumar Roy     |
| 5. Subrata Chakrabarty   | 15. Suvendu Hazra       |
| 6. Subhash Chandra Nandi | 16. Tathagata Banerjee  |
| 7. Rina Ghosh            | 17. Rabisankar Kulshi   |
| 8. Madhusudan Bhandari   | 18. Debasis Modak       |
| 9. Subhash Chandra Bagui | 19. Santipada Acharyya  |
| 10. Amitava Panda        | 20. Jyotsna Banerjee    |

**1979**

- |                          |                          |
|--------------------------|--------------------------|
| 1. Sarbani Chattopadhyay | 13. Pradip Kumar Dey     |
| 2. Biswajit Roy          | 14. Jaydev De            |
| 3. Saibal Chattopadhyay  | 15. Maniklal Rakshit     |
| 4. Asis Chattopadhyay    | 16. Ambujaksha Pratihar  |
| 5. Debiprasad Baidya     | 17. Prabhat Kumar Manna  |
| 6. Krishna Sarkar        | 18. Debashis Bose        |
| 7. Sukamal Saha          | 19. Gautam Chattopadhyay |
| 8. Atanushasan Basu      | 20. Tapas Manna          |
| 9. Amita Pathak          | 21. R. Padma             |
| 10. Pranab Mukherjee     | 22. Parthasarathi Lahiri |
| 11. Asis Ray             | 23. Suprakash Hazra      |
| 12. Sisir Kumar Samanta  | 24. Aranya Basu Roy      |

N.B. : Admission for the 1980 Session is yet to be finalised.



## Appendix 9

### GAURANGADAS KAYAL MEMORIAL PRIZE

Gaurangadas Kayal, an ex-student of the Department, died in a car accident sometime in June, 1965 in Washington, U. S. A., where he had gone for advanced study and research in statistics. After his death, his teacher, Prof. Tatsuo Kawata received a sum of Rs. 10,287.29 p. as the nominee of an accident insurance. Prof. Kawata sent the amount to the department with a desire of suitably investing the same amount to perpetuate the memory of Late Gourangadas Kayal. An additional amount of Rs. 4000/- was also received from Gourangadas Kayal's brother for the creation of an endowment to yield an annual income of Rs. 750/- approximately to (1) finance annual payment of M. A./M. Sc. Examination fees of three poor students and (2) further research works in the Department of Statistics. The disbursements of the fees and the scholarships have been being made respectively by the Registrar/The Audit and Trust Officer/Pro-Vice-Chancellor for Academic Affairs, Calcutta University on the recommendation of the Head of the Department.

#### Recipients of "GAURANGADAS KAYAL MEMORIAL BURSARY"

<i>Disbursed in the Year</i>	<i>As the M.A./M.Sc. Exam. Fees to the Students</i>	<i>As Research Grants to the Scholars</i>
1968	1967 Exam. Bimal Kumar Sinha Bikas Kumar Sinha Subrata Chattopadhyay	B. Das
1969	1968 Exam. R. Jagannathan S. B. Bagchi	J. Mukherjee B. Das
	1969 Exam. Swaraj Kumar Nath Sankarlal Sett Debsankar Gupta Subir Ghosh Arup Saha	
1970	1970 Pt. I Exam. Maitreyi Mukherjee Aparna Sarkar	
	1970 Pt. II Exam. Subir Ghosh Arup Saha Sadhan Samar Maity	





<i>Disbursed in the Year</i>	<i>As the M.A./M.Sc. Exam. Fees to the Students</i>	<i>As Research Grants to the Scholars</i>
1971	1971 Dilip Roy Pt. I Dibeyendu Majumdar Exam. Rajendra N. Panda Anjana Mitra Suchitra Ghosh  1971 Maitreyi Mukherjee Pt. II Aparna Sarkar Exam. Parthasarathi Chatterjee	Srijib Bhusan Bagchi
1972	1972 Premadhis Das Pt. I Sushil K. Paul Exam. Amit Kumar Ghosh Ruby Mitra  1972 Suchitra Ghosh Pt. II Swapan Kumar Das Exam. Raghunath Arnab Dilip Roy Dibyendranath Mazumdar Bhaskar Dasgupta Rajendra Nath Panda Anjana Mitra Tapan K. Dasgupta	
1978		Nanda K. Dey
1979		Rahul Mukherjee Prasanta De



## Appendix 10

### PROF. SAMARENDRANATH RAY MEMORIAL LECTURERSHIP

Prof. Samarendranath Ray, an eminent Statistician, was Head of the Department of Statistics before he migrated to the United States of America in 1950. He made considerable contributions in the fields of Multivariate Analysis, Testing of Hypothesis and Analysis of Categorical Data. Prof. Ray died, while on a holiday-cum-lecture tour in Canada on 23rd July, 1964.

The Secretary of Calcutta Statistical Association on behalf of it proposed to the University of Calcutta to handover a sum of Rs. 4,000/- by raising contributions for creating an endowment entitled "Professor Samarendranath Ray Memorial Lecturership" to finance a triennial Lecturership in order to commemorate the great statistician on the recommendation of a Special Committee for the appointment of the same—the Committee being constituted with the Vice-Chancellor, the Vice-President, University College of Science, the Heads of the departments of Statistics, Pure Mathematics and Applied Mathematics, Calcutta University and two representatives of the Calcutta Statistical Association. It was also decided that there should be at least two lectures on Theoretical and Applied statistics as well as on allied subjects, and an honorarium of Rs. 600/- only is to be paid to the distinguished scholar for delivering the lecture.

It was formally accepted by the Senate on 16.4.66. An additional sum of Rs. 600/- was also given by the Association to the University in order to start the lecture from 1966.

#### THE LIST OF LECTURERS

<i>Sl. No.</i>	<i>Name</i>	<i>Designation and Address</i>	<i>Topic of the Lecture</i>	<i>Delivered on</i>
1.	Prof. R. C. Bose	A former Head of the Department of Statistics, Calcutta University and an intimate associate of Prof. S. N. Ray. Professor of Mathematical Statistics, University of North Carolina, Chapel Hill, North Carolina, U. S. A.	'Error correcting codes' 1st lecture for 1966.	4th & 5th July, 1966, at the 2nd floor, Darbhanga Buildings.



<i>Sl No.</i>	<i>Name</i>	<i>Designation and Address</i>	<i>Topic of the lecture</i>	<i>Delivered on</i>
2.	Dr. P. V. Sukhatme	Formerly, Chief Statisticians Branch, F.A.O., Rome. Gokhale Institute of Politics & Economics, Poona.	'Protein Malnutrition - its nature and implications'. 2nd lecture for 1969.	25th and 26th July, 1974, in the Deptt. of Statistics, C.U.
3.	Harald Cramer	University of Stockholm, Norway.	'The rise and Early Development of the Theory of Stochastic Processes. 3rd lecture for 1972.	21st Feb., 1977, in the Deptt. of Stat. C. U.
4.	Dr. L. Pasinetti	Profassor of Economics, Catholic University of Milan, Fellow, Kings College, Cambridge.	'Simultaneous Equation versus Casual Chains in Economic Analysis'. 5th lecture for 1978.	9th March, 1979, in the Deptt. of Stat. C.U.
5.	Prof. P. K. Sen	University of North Carolina at Chapel Hill, U. S. A.	'Nonparmetric Methods in Growth Curve Models'. 4th lecture for 1975.	21st and 22nd August, 1979, in the Deptt. of Stat., C.U.



# Appendix 11

## M. A./M. Sc. TEXT-BOOKS IN STATISTICS

(As approved by the University of Calcutta in early forties)

### *Theoretical Statistics (Papers I and II) :*

Aitken, A. C.	Statistical Mathematics.
Fisher, A.	The Mathematical Theory of Probability.
Fisher, R. A.	Statistical Methods for Research Workers.
Fisher, R. A.	The Design of Experiments.
Fisher, R. A.	The Statistical Theory of Estimation. (Calcutta University Lectures).
Kenney, J. F.	Mathematics of Statistics (Parts I & II).
Neyman, J.	Lectures and Conferences on Mathematical Statistics.
Tchuprow, A. A.	Principles of the Mathematical Theory of Correlation.
Uspensky, J. V.	Introduction to Mathematical Probability.
Whittaker, E. T. & Robinson, G.	The Calculus of Observations.
Wilks, S. S.	Statistical Inference.
Yule, G. U. & Kendall, M. C.	An Introduction to the Theory of Statistics.

### *Applied Statistics (Paper III) :*

Ezekiel, M.	Methods of Correlation Analysis.
Fry, T. C.	Probability and its Engineering Uses.
Garret, H. E.	Statistics in Psychology and Education.
Goulden, C. H.	Methods of Statistical Analysis.
Kelley, T. L.	Interpretation of Educational Measurements.
Mills, F. C.	Statistical Methods Applied to Economics and Business.
Pearl, Raymond	Introduction to Medical Biometry and Statistics.

\*Referred to as a matter of curiosity and vital importance in respect of the early history of Statistical Science in India





- |   |   |
|---|---|
| Pearson, E. S.                            | Application of Statistical Methods to Industrial Standardization and Quality Control.   |
| Shewhart, W. A. (Edited by Deming, M. E.) | Statistical Methods from the view point of Quality Control.   |
| Snedecor, G. W.                           | Analysis of Variance and Covariance.  |
| Tippett, L. H. C.                         | The Methods of Statistics.  |
| Wishart, J. & Sanders, H. G.              | Principles and Practice of Field Experimentation.   |
| Whipple, G. S.                            | Vital Statistics.   |
| <i>Practical (Paper IV)</i>               |   |
| Arkin, H. & Colton, R. R.                 | Statistical Methods.<br>Barlow's Tables of Squares, Cubes, etc.)  |
| Brunt, D.                                 | The Combination of Observations.<br>Chamber's Logarithmic and Trigonometric Tables (7 figures).   |
| Dawson, Shephard                          | An Introduction to the Computation of Statistics.   |
| Elderton, W. P.                           | Frequency Curves and Correlation.   |
| Fisher, R. A. & Yates. F.                 | Statistical Tables for Biological, Agricultural & Medical Research.<br>Mathematical Tables No. 1 (Published by the Statistical Laboratory, Calcutta). |
| Pearson, Karl,                            | Tables for Statisticians and Biometricians, Part I.<br>Random Numbers (Any suitable publication).   |
| Scarborough, J. B.                        | Numerical Mathematical Analysis.<br>Tables of Random Samples from a Normal Population.  |

*Special Papers (V-VIII)*

The subject was taught according to the Syllabus mostly from original papers and research memoirs.



## Appendix 12

The Evolution of the M.A./M.Sc. Syllabuses in Statistics of C. U., through the four decades

12 A THE PATTERN OF M.A./M.Sc. COURSE IN STATISTICS, OF C. U. AS WAS MAINLY FOLLOWED FROM 1941 TO 1970 WITH LITTLE ADDITION OR ALTERATION FROM TIME TO TIME

(Quoted from *University of Calcutta Regulations, 1941*)

1. The course in Statistics shall be divided into a number of groups. The first four papers of each group shall be identical and shall consist of three written papers, each of four hours and each carrying 100 marks and a practical examination (extending over at least one day) carrying 100 marks.

*Papers I and II* : General Methods of Statistics

*Paper III* : Applied Statistics

*Paper IV* : Practical Examination

2. The remaining *four papers* shall be taken from any one of the following groups :— Group A—Mathematical Statistics, Group B—Economic and Business Statistics, Group C—Applied Statistics.

In each group there shall be two written papers of four hours each, carrying 100 marks and a practical examination carrying 200 marks but in the case of Group A (Mathematical Statistics) the candidates shall have the option of taking two papers in Mathematics approved by the Board of Higher Studies in Statistics in lieu of the practical examination.

3. Candidates must produce note-books of their laboratory work, which must be duly certified by the Professor and shall be taken into account in estimating their qualifications.

4. The list of groups may be added to or modified from time to time by the Board of Higher Studies in Statistics. The detailed distribution of papers in each group shall be settled from time to time by the Board of Higher Studies in Statistics.

5. The Syllabus for each paper shall be defined and books shall be recommended from time to time by the Board of Higher Studies in Statistics to indicate generally the extent and standard of knowledge required.





\*6. Candidates, who have taken their B.A. or B.Sc. Degree with Honours in Statistics or Mathematics or Economics or in such science subjects as may be approved by the Board of Higher Studies in Statistics from time to time, may be permitted to offer a piece of research work in lieu of two papers in the optional subjects and the maximum marks allotted to the thesis shall be 200.

In order to pass in Statistics a candidate must obtain 30% of the aggregate marks prescribed for theoretical papers and 40% of the marks set apart for Practical Examinations. If in any Theoretical Paper a candidate obtains less than 25 marks these marks shall not be included in his aggregate. Candidates obtaining 360 marks shall be placed in the Second Class and those obtaining 480 marks in the First Class.

## 12 B THE OUTLINE SYLLABUS FOR M.A./M.Sc. EXAMINATIONS IN STATISTICS OF C.U., FOLLOWED AROUND 1945

- |           |  |
|-----------|--|
| Paper I   | (a) Probability (b) Numerical Mathematics<br>(c) Descriptive Statistics  |
| Paper II  | (a) Theoretical Statistics (including Large Sample theory).<br>(b) Testing of Hypothesis and some advanced Distributions   |
| Paper III | (a) Vital Statistics<br>(b) Educational Statistics<br>(c) Industrial & Economic Statistics   |
| Paper IV  | General Practical  |
| Paper V   | (a) Design & Analysis of Field Experiments<br>(b) Sample Survey  |
| Paper VI  | (a) Genetics & Theory of Estimation<br>(b) Economics   |
| Paper VII | Practical<br>(a) Agricultural Statistics (upto split plot and symmetrical confounding)<br>(b) Economic Statistics (Seasonal trend, Moving Averages etc. and Official)<br>(c) Sample Survey |

\*This permission continued only for a few years.



# Paper VIII

## Practical

- (a) Vital Statistics
- (b) Economic Statistics
- (c) Agricultural Statistics (Advanced) (Incomplete Balanced, Partially balanced, Uniformity Trial, shape & size of plots)

## 12 C THE DETAILED SYLLABUS FOR M.A./MSc. EXAMINATIONS IN STATISTICS OF C.U., IN FORCE FROM 1952.

### First Paper :

#### *Mathematical Preliminaries*

Algebra—Linear Algebra, Vectorspaces, Orthogonal transformations, Matrices, Determinants, Quadratic forms, Reduction of quadratic forms.

Analysis—Convergence of infinite series and sequences, uniform convergence, continuous functions, Riemann integrals, double integral, transformation of multiple integrals, analytic function of a complex variable, Cauchy's theorem, Taylor's and Laurent series, residues evaluation of integrals.

#### *Probability*

Classical definition of mathematical probability, the laws of compound and total probability, mathematical expectations, Tshebysheff's and Khintchin's law of large numbers, convergence of sequence of random variables. Kolmogoroff's law of large numbers, continuous probability, inverse probability and Bayes' theorem, characteristic functions and their applications, Glivenko-Cantelli's theorem.

#### *Numerical Analysis*

Interpolation formulae with errors (Newton, Lagrange, Gauss, Stirling, Bessel and Everett), inverse interpolation, subtabulation, double interpolation, numerical differentiation, numerical integration, Remainder in Euler-Maclaurin form, Stirling's approximation for the factorial ; numerical solution of equation, approximation of a periodic function by a finite Fourier's series—12 ordinate scheme.

Evaluation of incomplete probability integrals of important multivariate distributions, classical and studentised  $D^2$ -statistic, and p-statistics (under null hypothesis), recurrence relations and the construction of statistical tables.

#### *Descriptive Statistics*

Pearsonian and Gram-Charlier systems of frequency curves, Bessel curves, graduation of frequency curves, the normal curve and its properties, bivariate data, co-efficients of association, correlation and linear regression, correlation ratio and curvilinear regression—orthogonal polynomials, rank correlation, intra-class



correlation, bivariate normal distribution and its properties, multivariate data, multiple regression and correlation, partial correlation, intra-class correlation, multivariate normal distribution and its properties, study of structural relationship, confluence analysis, estimation of simultaneous equation system, etc., theory of errors and method of least squares.

## **Second Paper :**

### *Statistical Inference*

Theory of testing hypothesis simple and composite hypothesis, different types of optimum critical regions—A and  $A_1$ , B and  $B_1$ , C and D ; status of all the well-known tests of significance, theory of sequential tests.

Theory of point estimation, consistency, efficiency and sufficiency, maximum likelihood estimates and their properties, information theory, estimation by intervals. Elements of non-parametric inference. Elements of decision theory.

### *Sampling Distributions*

Distribution of linear functions of normal variates, distribution of central and non-central  $\chi^2$ , sum of  $\chi^2$ 's, ratio of two  $\chi^2$ 's distribution of simple correlation, multiple correlation and partial correlation, distributions connected with tests of significance of total and partial regression coefficients and linearity of regression, joint distribution of variances and covariances from a normal multivariate population. Distribution of Hotelling's  $T^2$ .

### *Large Sample Theory*

Limit theorems, distribution of the statistics— $p$ ,  $t$ ,  $z$ ,  $\chi^2$ , in the large sample, transformation of variates—its application to  $p$ ,  $s$ ,  $r$ , distribution of frequency  $\chi^2$  and its applications, standard errors of moment statistics, cumulants, distribution of percentiles, Sheppard's corrections.

## **Third Paper :**

### *Economic Statistics*

Index numbers of prices, cost of living and production, time series trends—seasonal for accountable causes—harmonic analysis—forecasting and correlation of time series ; national dividend—Pareto's Law of income distribution ; family budget enquiries—Engel's curves ; demand analysis for non-durable consumer's goods from time series and family budget data, indifference curves.

### *Official Statistics*

Discussion of the current official statistics of India—methods of compilation, presentation and their critical study.



### *Sample Surveys*

General concepts : sampling frames, records forms, questionnaires, etc., organisation of field—investigation and processing of data of sample surveys observational errors ; writing of reports. Any recent sample surveys in India.

Detailed study of two-stage sampling ; general multi-stage sampling ("equal size" case without f. p. c.) : stratified sampling ; with fixed units ; stratified area sampling with units of variable size but constant within a stratum ; systematic sampling for one-dimensional, discrete sequence ; double sampling with one auxiliary variate. Topographic variation—contour maps, space correlation and different types of statistical fields.

### **Fourth Paper :**

( *Practical* )

Practical work on the application of general statistical methods to actual problems.

### **Fifth Paper :**

*Theory of Linear Estimation*

The estimation and the errors spaces, the fundamental theorem of linear estimation and the theory of least squares, sum of squares belonging to one or more degrees of freedom, the analysis of variance and co-variance.

*Analysis and construction of Experimental Designs*

Incomplete block designs including balanced and partially balanced designs, group divisible designs and lattice designs ; two-way elimination of heterogeneity—Latin squares and Youden squares ; the combinatorial problems of the construction of orthogonal sets of Latin squares, and balanced and partially balanced incomplete block designs ; inter-block and intra-block information ; missing-plot technique ; factorial experiments ; confounding and its use ; partial confounding and balancing of  $2^3$ ,  $2^4$ ,  $2^5$ ,  $3^3$  and  $3^4$  designs, simple types of asymmetrical factorial designs—split-plot designs, quasialatin squares ; double confounding ; fractional replications ; weighing designs.

### **Sixth Paper :**

*Genetics*

Descriptive genetics, elements of cytology, autosomal and chromosomal inheritances for a single character and for more than one character with or without linkage, chromosomal and autosomal maps, human genetics and blood groups, application of statistical methods to genetics—method for testing Mendelian hypothesis for individual character and for detection and estimation of linkage in simple cases, combined estimation and testing hetero-





geneity, study of disturbed segregations methods for the detection and estimation of linkage in human genetics.

### *Statistical Quality Control*

Control charts, sampling problems, single sampling, double sampling and sequential sampling inspection plans, sampling inspection for continuous production, standardization and specification.

### *Educational Statistics*

Scaling procedures construction and standardisation of tests, theory of mental tests, problems of classification and discrimination, problem of weighing and differential prediction, multiple factor analysis.

### *Vital Statistics and Bio-assays*

Sources of vital statistics, construction of mortality tables, studies on mortality tables, standardization of rates, fertility table, computation of standard indices of population growth, stationary population, graduation by Makeham's Law and Gompertz Law, standard tables and summation method, population dynamics and logistic curve. Probit analysis.

### **Seventh Paper :**

*(Practical)*

Practical work on the applications of specialised statistical techniques to analysis of field trials, economic data and problems in sample surveys.

### **Eighth Paper :**

*(Practical)*

Practical work on the applications of specialised statistical techniques to population statistics and educational problems ; numerical study of problems of estimation, testing of hypothesis, etc.

Viva-voce.

## **12 D THE DETAILED SYLLABUS FOR M.A./M. Sc. EXAMINATIONS IN STATISTICS OF C.U., IN FORCE FROM 1961**

### **First Paper : First Half**

Probability, Mathematical Analysis.

*Probability*—Classical definition of mathematical probability, the laws of compound and total probability, mathematical expectations, Tshebysheff's and Khintchin's law of large numbers, convergence of sequence of random variables. Kolmogoroff's law of large numbers, continuous probability, inverse probability and Bayes' theorem, characteristic functions and their applications, Glivenko-Cantelli's theorem.





*Analysis*—Convergence of infinite series and sequences, uniform convergence, continuous functions, Riemann integrals, double integral, transformation of multiple integrals, analytic function of a complex variable, Cauchy's theorem, Taylor's and Laurent series, residues, evaluation of integrals.

### **First Paper : Second Half**

Algebra, Numerical Analysis.

*Algebra*—Linear Algebra, Vectorspaces, Orthogonal transformations, Matrices, Determinants, Quadratic forms, Reduction of quadratic forms.

*Numerical Analysis*—Interpolation formulae with errors (Newton, Lagrange, Gauss, Stirling, Bessel and Everett), inverse interpolation, subtabulation, double interpolation, numerical differentiation, numerical integration, Remainder in Euler-Maclaurin form, Stirling's approximation for the factorial; numerical solution of equations, approximation of a periodic function by a finite Fourier's series—12 ordinate scheme, Numerical solution of Differential Equations, Solution of Difference equation by the method of 'Relaxation.'

Evaluation of incomplete probability integrals of important multivariate distributions, classical and studentised  $D^2$ -statistic, and  $p$ -statistic (under null hypothesis), recurrence relations and the construction of statistical tables.

### **Second Paper : First Half**

Statistical Methods and Sampling Distributions from Univariate and Bivariate Distributions.

*Descriptive Statistics*—Pearsonian and Gram-Charlier systems of frequency curves, Bessel curves, graduation of frequency curves, the normal curve and its properties, bivariate data, coefficients of association, correlation and linear regression, correlation ratio and curvilinear regression—orthogonal polynomials, rank correlation, intra-class correlation, bivariate normal distribution and its properties, multivariate data, multiple regression and correlation, partial correlation, partial regression, multivariate normal distribution and its properties, study of structural relationship, confluence analysis, estimation of simultaneous equation system, etc., theory of errors and method of least squares.

*Sampling Distributions*—Distribution of linear functions of normal variates, distribution of central and non-central  $\chi^2$ , sum of  $\chi^2$ 's, ratio of two  $\chi^2$ 's, distribution of simple correlation and regression.



### **Second Paper : Second Half**

Multivariate Analysis, Large Sample Theory.

*Sampling Distributions*—Distribution of multiple correlation and partial correlation, distributions connected with tests of significance of partial regression coefficients and linearity of regression, joint distribution of variances and covariances from a normal multivariate population. Distribution of Hotelling's  $T^2$ .

*Large Sample Theory*—Limit theorems distribution of the statistics  $p$ ,  $t$ ,  $z$ ,  $x^2$  in the large sample, transformation of variates—its application to  $p$ ,  $s$ ,  $r$ , distribution of frequency  $x^2$  and its applications, standard errors of moment statistics cumulants ; distribution of percentiles, Sheppard's corrections.

### **Third Paper : First Half**

Theory of Inference I.

Theory of point estimation, consistency, efficiency and sufficiency, maximum likelihood estimates and their properties, information theory, estimation by intervals.

Elements of non-parametric inference (estimation). Elements of decision theory (estimation).

### **Third Paper : Second Half**

Theory of Inference II.

Theory of Testing of hypothesis, simple composite hypothesis, different types of optimum critical regions— $A$  and  $A_1$ ,  $B$  and  $B_1$ ,  $C$  and  $D$  ; status of all the well-known tests of significance, theory of sequential tests.

Elements of non-parametric inference. Elements of decision theory.

### **Fifth Paper : First Half**

Sample Survey, Genetics.

*Sample Surveys*—General concepts : sampling frames, records, forms, questionnaires, etc., Organisation of field—investigation and processing of data of sample survey ; Observational errors ; writing of reports. Any recent sample surveys in India.

Detailed study of two-stage sampling ; general multi-stage sampling ("equal size" case without f.p.c.) : stratified sampling with fixed units ; area stratified sampling with units of variable size but constant within stratum ; systematic sampling for one-dimensional, discrete sequence ; double sampling with one auxiliary variate. Topographic variation—contour maps, space correlation and different types of statistical fields.



*Genetics*—Descriptive genetics, elements of cytology, autosomal and chromosomal inheritances for a single character and for more than one character with or without linkage, chromosomal and autosomal maps, human genetics and blood groups, application of statistical methods to genetics—method for testing Mendelian hypothesis for individual character and for detection and estimation of linkage in simple cases, combined estimation and testing heterogeneity, study of disturbed segregations methods for the detection and estimation of linkage in human genetics.

### **Fifth Paper : Second Half**

Design and Analysis of Experiments.

*Theory of Linear Estimation*—The estimation and the error spaces, the fundamental theorem of linear estimation and the theory of least squares, sum of squares belonging to one or more degrees of freedom, the analysis of variance and co-variance.

*Analysis and Construction of Experimental Designs*—Incomplete block design including balanced and partially balanced designs, group divisible designs and lattice designs ; two-way elimination of heterogeneity—Latin squares and Youden squares ; the combinatorial problems of the construction of orthogonal sets of Latin squares, and balanced and partially balanced incomplete block designs ; inter-block and intra-block information ; missing-plot technique ; factorial experiments ; confounding and its use ; partial confounding and balancing, detailed study of confounding and balancing of  $2^k$ ,  $2^4$ ,  $2^5$ ,  $3^k$  and  $3^4$  designs, simple types of asymmetrical factorial designs, split-plot designs, quas latin squares ; double confounding ; fractional replications ; weighing designs

### **Sixth Paper : First Half**

Economic Statistics, Quality Control.

*Economic Statistics*—Index numbers of prices, cost of living and production, time series trends—seasonal for accountable causes—harmonic analysis—forecasting and correlation of time series ; national dividend—Pareto's Law of income distribution ; family budget enquiries—Engel's curves ; demand analysis for non-durable consumer's goods from time series and family budget data, indifference curves.

*Official Statistics*—Discussion of the current official statistics of India—methods of compilation, presentation and their critical study.





*Statistical Quality Control*—Concept of total quality control, control charts, sampling inspection plans (single, double and sequential), sampling inspection for continuous production, standardization and specification, work sampling.

### **Sixth Paper : Second Half**

Psychometry, Demography & Bioassay.

*Psychometry*—Psychophysical laws, theory of mental tests, problem of weighting and differential prediction, problems of classification and discrimination, factor analysis, scaling procedures.

*Demography*—Sources of vital statistics, construction of mortality tables standardization of rates, fertility table, computation of standard indices of population growth. Stationary population, graduation by Makeham's Law and Gompertz Law, standard tables and summation method, population dynamics and logistic curve.

*Bioassay*—Direct assays, quantitative dose-response relationships, parallel line assays probit transformations.

Practical : Total Marks—240

Paper IV—Based on Papers I and II

Paper VII—Based on Papers V and VI

Paper VII—Based on Papers V and VI (*Economic Statistics*)

Paper VIII—Based on Papers III and VI (Remaining topics)

Practical Record Book—30 marks

Viva Voce—30 marks.

12 E, REVISED OUT-LINE SYLLABUS FOR THE M.A./M.Sc. EXAMINATIONS IN STATISTICS OF C.U., IN FORCE FROM 1972

**Part I Examination : Total Marks—500**

*Theoretical (350 marks) :*

Paper I *Mathematics*—75 marks

Analysis

—50 marks

Algebra

—25 marks

Paper II *Probability & Numerical Mathematics*—75 marks

Probability

—50 marks

Numerical Mathematics

—25 marks





Paper III	<i>Statistical Methods I</i> —75 marks	
	Sampling Distribution	—30 marks
	Testing of Hypothesis	—45 marks
Paper IV	<i>Statistical Methods II</i> —75 marks	
	Theory of Estimation (including linear estimation)	—50 marks
	Large Sample Theory	—25 marks
Paper V	<i>Applied Statistics I</i> —50 marks	
	Economic Statistics	—30 marks
	Demography	—20 marks
<i>Practical (150 marks) :</i> (including 30 marks for class work and 20 marks for viva-voce test).		

**Part II Examination : Total Marks—500***Theoretical*

Paper VI	<i>Applied Statistics II</i> —50 marks	
	Design and Analysis of Experiments	—25 marks
	Sample Survey	—25 marks

*Practical* Based on Paper VI—50 marks  
(including 10 marks for class work)

**Special Papers—400 marks**

Special topics were divided into two groups as follows. One topic from Group A and two topics from Group B had to be chosen. Two alternative combinations of special topics were allowed each year as determined by the Board.

- Group A :** (1) Advanced Probability (theoretical—200 marks)  
(2) Inference (theoretical—200 marks)  
(3) Multivariate Analysis (theoretical—150 marks and practical—50 marks)  
(4) Design and Analysis of Experiments  
(theoretical—150 marks and practical—50 marks)

**Group B :** Under each topic 75 marks were allotted to theoretical and 25 marks to practical papers

- (1) Biometry, Genetics & Bioassay
- (2) Time Series
- (3) Study of Structural Relations
- (4) Psychometry



- (5) Quality Control including Reliability and Life Testing
- (6) Sample Surveys
- (7) Mathematical Programming
- (8) Operations Research

## 12 E<sub>2</sub> THE DETAILED SYLLABUS (1972) FOR THE COMMON THEORETICAL PAPERS I TO VI

### Paper I *Mathematics*

*Analysis*—Convergence of infinite series and sequences, uniform convergence, continuous functions, convex functions, extrema of functions, Riemann integrals-double integral, transformation of multiple integrals. Riemann-Stieltjes integral; measures and Lebesgue integrals (results covered by the mathematical portion of Cramer's book 'Mathematical Methods of Statistics').

Analytic function of a complex variable, Cauchy's theorem, Taylor's and Laurent series, residues, evaluation of integrals.

*Algebra*—Linear algebra, vector spaces, matrices and determinants, solution of linear equations, quadratic forms. Difference equation.

### Paper II *Probability and Numerical Analysis*

*Probability*—Axiomatic definition of probability, random variable, mathematical expectation; problems of probability calculus-geometric probability, application of difference equation, etc., generating functions; convolutions; weak and strong laws of large numbers; convergence of sequence of random variables.

Characteristic functions (including the inversion theorem) and their applications.

Limit theorems—continuity theorem for a sequence of characteristic functions, central limit theorem (proof in the i.i.d. and statement in the general case).

*Numerical Analysis*—Summation method; numerical integration (Gregory, Lubbock, Tschebyscheff, Hardy and Lobatto formulae); solution of differential equations (Euler, Picard and Runge-Kutta methods); relaxation method of solution. Data Processing.

### Paper III *Statistical Methods-I*

*Sampling Distribution*—Non-central distribution of  $\chi^2$ , t, F. Samples from multivariate normal population-independence of sample means and sample variances and covariances; distribution of multiple correlation coefficient, partial correlation coefficient and intra-class correlation coefficient; distributions connected with tests of significance for linear hypotheses; distributions of Hotelling's T<sup>2</sup>. Applications of these distributions for inference problems.



*Testing of Hypotheses*—Simple and composite hypothesis, similar tests, monotone likelihood, UMPU tests, randomised tests, likelihood ratio criterion.

*Sequential tests*—sequential probability ratio test—approximate determination of boundaries, determination of OC and ASN, approximate proof of the optimum property.

*Non-parametric tests* for two-sample problem, goodness of fit test, tests of randomness. Decision theoretic approach to simple testing problems—case of finite number of alternative decisions.

#### Paper IV *Statistical Methods—II*

*Theory of Estimation*—Theory of point estimation consistency, efficiency, sufficiency, complete sufficiency, lower bounds of variances of estimates, maximum likelihood estimates and their properties. Interval estimation. Non-parametric estimation, estimation of percentiles, point and interval; tolerance limits. Decision theoretic approach to simple problems of estimation—admissibility, minimax principle. Bayes solution.

*Theory of Linear Estimation*—The estimation and error spaces; the fundamental theorem of linear estimation and the theory of least squares.

*Large Sample Theory*—Limit theorems concerning functions of sequences of random variables; large sample distributions of standard statistics; transformation of variates for stabilizing the variance; distribution of frequency  $\chi^2$  and its applications; standard errors of moment statistics; distribution of quantiles and order statistics.

#### Paper V *Applied Statistics—I*

*Economic Statistics*—Analysis of family budget data—Engel's curves and cost of living index numbers.

*Analysis of time series*—moving averages, variate difference method, correlation between two time series, tests of randomness.

*National income and its methods of estimation.*

*Laws of income distribution.*

*Discussion of the current official statistics of India*—methods of compilation, presentation and their critical study.

*Demography*—Measurement of morbidity, mortality, comparisons, population growth and its measurement, methods of graduation; population estimation and projection,

#### Paper VI *Applied Statistics—II.*

*Design and Analysis of Experiments*—Analysis of non-orthogonal data, balanced incomplete block design with recovery of inter-block information and



Youden square. Missing plot technique. Construction of a complete set of orthogonal Latin Squares and balanced incomplete block designs (simple applications of method of differences and finite geometry).

Factorial experiments—confounding and balancing in the  $s^m$  case with special reference to  $s=2,3$ .

*Sample Survey*—Effects of bias on estimates ; errors in a survey.

PPS sampling (with replacement) ; stratified random sampling-comparison with simple random sampling, construction of strata, ratio and regression methods of estimation.

Systematic sampling—variance of the estimated mean, general comparisons with simple and stratified random sampling. General multi-stage sampling (equal size case).

Planning and organisation of large-scale sample surveys.

*Detailed Syllabus for the special topics will be decided each Year.*

## 12 E, AMENDMENT OF THE 1972 SYLLABUS

The redistribution of the topics and allotment of marks thereto in the special papers for the M.A./M.Sc. Examinations in Statistics of C.U., in force from 1972, as accepted by the Academic Council on 24.7.75.

Paper VII *Design & Analysis of Experiments*—75 marks

Analysis of Variance and Efficiency of Experimental Designs ... 30 marks

Factorial Experiments & Response Surface Designs ... 45 marks

Paper VIII *Design & Analysis of Experiments*

Latin Squares, Orthogonal Arrays Incomplete Block Designs, Sequence of Experiments & Weighing Designs ... 75 marks

Paper VII *Multivariate Analysis*

Characterization of normal distribution, Sampling distribution, Estimation, Tests of Significance, Confidence Regions, Complex Multivariate Analysis ... 75 marks

Paper VIII *Multivariate Analysis*—75 marks

Optimum properties of tests and problem of classification ... 30 marks

Non-parametric methods (including relevant uni-parametric results) ... 45 marks





Paper IX	<i>Sample Surveys—75 marks</i>	
	Unified Sampling Theory. Sampling with probability proportional to size. Comparison of methods of sampling with and without replacement in case of equal probability sampling	... 45 marks
	Cluster sampling. Systematic sampling. Two-stage sampling with primary units of unequal sizes. Double sampling techniques. Inverse sampling. Ratio product and difference estimators (for two variate case)	... 30 marks
Paper X	<i>Operations Research—75 marks</i>	
	Introductory topics and Allocation Models	... 30 marks
	Inventory, Replacement and Queueing Models	... 45 marks
Paper X	<i>Quality Control including Reliability &amp; Life-testing—75 marks</i>	
	Process and Product Control	... 50 marks
	Life-testing and Reliability	... 25 marks

This took effect from the M.A./M.Sc. Part II Examination of 1974

## 12 F, THE OUTLINE SYLLABUS FOR M.A./M.Sc. EXAMINATIONS IN STATISTICS OF C. U., IN FORCE FROM 1978

### Part I Examination : Total Marks—500

#### Theoretical—350 Marks

Paper I	<i>Analysis and Probability—75 marks</i>	
	Analysis	— 50 marks
	Probability	— 25 marks
Paper II	<i>Algebra, Elements of Data Processing and Sampling Distributions—75 marks</i>	
	Algebra and Elements of Data Processing	— 35 marks
	Sampling Distributions	— 40 marks
Paper III	<i>Statistical Inference-I—75 marks</i>	
	Theory of Estimation	— 30 marks
	Theory of Testing of Hypotheses	— 45 marks
Paper IV	<i>Theory of Linear Models and Design and Analysis of Experiments—75 marks</i>	
	Theory of Linear Models	— 30 marks
	Design and Analysis of Experiments	— 45 marks



**Paper V      *Applied Statistics-I*—50 marks**

Sample Surveys	— 20 marks
Industrial Statistics	— 20 marks
Statistical System in India	— 10 marks

***Practical—150 marks***

Section I : Based on papers II and III—40 marks ; Section-II : Based on paper IV—40 marks ; Section-III : Based on paper V—40 marks ; Viva-voce—15 marks and Laboratory Note Book—15 marks.

**Part II Examination : Total Marks—500*****Theoretical—350 marks*****Paper VI      *Stochastic Process*—50 marks****Paper VII      *Statistical Inference-II*—75 marks**

Selected topics of Inference, Decision Theory	— 40 marks
Nonparametric Methods	— 35 marks

**Paper VIII      *Applied Statistics-II*—75 marks**

Econometrics	— 35 marks
Mathematical Programming	— 25 marks
Demography	— 15 marks

**Paper IX      *Special Paper*—75 marks**

*Multivariate Analysis or Advanced Design & Analysis of Experiments*

**Paper X      *Special Paper*—75 marks**

*Advanced Sample Surveys or Operations Research*

***Practical—160 marks***

Section-I : Based on paper VII—40 marks ; Section-II : Based on paper VIII—40 marks ; Section-III : Based on papers IX and X—40 marks (Special Papers), Viva-Voce—20 marks and Laboratory Note Book—10 marks.

## 12 F, THE DETAILED SYLLABUS FOR M.A./M.Sc. EXAMINATIONS IN STATISTICS OF C. U., IN FORCE FROM 1978

**Paper-I      *Analysis and Probability***

***Analysis***—Cluster-points of sets of numbers, closed and open sets. Convergence of sequences and series. Continuity and Differentiability of functions. Convex functions, Extrema of functions. Riemann integrals. Series of functions, uniform convergence, power-series. Double and multiple integrals. Riemann-Stieltjes integrals. Lebesgue-measurable sets and Lebesgue measure, Lebesgue integral, Monotone and Dominated Convergence Theorems, differentiation and integration under the Lebesgue integral sign.



Analytic functions of a complex variable. Cauchy's Theorem. Taylor's and Laurent's Series. Residues. Evaluation of integrals.

*Probability*—Probability axioms, random variables, mathematical expectations. Convergence of sequences of random variables. Weak and Strong Laws of Large Numbers. Glivenko-Cantelli Theorem. Characteristic function, inversion and continuity theorems. Central Limit Theorem (proof only in the i.i.d. case.)

Paper-II *Algebra and Elements of Data Processing, and Sampling Distributions*

*Algebra and Elements of Data processing*—Vector spaces. Matrices and determinants. Solution of linear equations, use of the generalized inverse of a matrix. Quadratic forms and their canonical reduction. Characteristic roots and vectors of square matrices. Solution of difference equations.

Data transcription. Computer logic and switching circuit analysis. Digital Computer, its structure and functions. Computer language and programming.

*Sampling Distributions*—Noncentral distributions of  $\chi^2$ ,  $t$  and  $F$ . Distribution of  $t$ -and  $F$ -statistics for linear hypotheses. Distribution of quadratic forms, Cochran's Theorem. Samples from multivariate normal populations, quadratic independence of sample mean vector and dispersion matrix. Wishart distribution. Distribution of partial and multiple correlation coefficients and regression coefficients. Distribution of intraclass correlation coefficient. Distribution of Hotelling's  $T^2$ .

Asymptotic distribution of moments and functions of moments. Transformation of statistics. Distribution of order statistics and quantiles.

Paper-III *Statistical Inference-I*

*Theory of estimation*—Problems of inference. Sufficiency and Factorization Theorem. Exponential family of distributions.

Point estimation. Minimum variance unbiased estimation. Lower bounds to variances of estimates. Rao-Blackwell Theorem, complete sufficiency. Criteria for estimates based on large samples, consistency and asymptotic efficiency. Methods of estimation. Optimum properties of maximum likelihood estimates.

Interval estimation, relation with hypothesis testing. Optimum parametric confidence intervals.

*Theory of Hypothesis Testing*—Non-randomized and randomized tests, critical functions, power.

Simple hypothesis. UMP tests. Neyman Pearson Lemma. Families with monotone likelihood ratio. UMPU tests.



Composite hypothesis. UMPU tests. Similar tests, Neyman structure. Likelihood ratio technique.

Tests involving multinomial proportions, asymptotic distribution of frequency  $\chi^2$  for simple and composite hypotheses.

Sequential tests. SPRT, approximate determination of boundaries. OC and ASN of SPRT. Optimality of SPRT (proof under the usual approximation).

*Paper-IV Theory of Linear Models and Design and Analysis of Experiments*  
*Theory of Linear Models*—Fixed effects model. Estimation and errors, estimable function, BLUE and Gauss Markov Theorem. Tests of linear hypotheses and related confidence regions, Scheffe's and Tukey's multiple comparison techniques. Applications to problems of regression, analysis of variance and covariance. Nonorthogonal data, connectedness. Other models for analysis of variance in the balanced case.

*Design and Analysis of Experiments*—Varietal designs eliminating heterogeneity in one or more directions. BIB, Latice and PBIB designs. Latin squares, Youden squares Graeco-Latin squares. Recovery of interblock information. Missing plot techniques. Combinatorial problems in the construction of complete sets of orthogonal Latin squares, BIB, and GD designs.

Factorial experiments. Confounding, balancing and fractional, replication in symmetric factorials. Split plot and strip designs.

#### *Paper-V Applied Statistics-I*

*Sample Surveys*—Probability sampling from a finite population. Simple random sampling. Systematic sampling. Varying probability sampling with replacement. Stratification, construction of strata. Ratio and regression methods of estimation and their extensions, use in stratified sampling. Cluster sampling. Subsampling of clusters, selection of primary units with equal (with/without replacement) and unequal (with replacement) probabilities subsampling after stratification. Interpenetrating samples. Nonresponse. Planning and organization of largescale sample surveys.

*Industrial Statistics*—Modified control charts, Group control charts. Control charts for coefficient of variation and extreme values. Cusum charts.

Acceptance sampling. Inspection by attribute and count of defects. LTPD, AOQL, and AQL plans. Sequential inspection. Continuous inspection. Inspection by variables.

Tolerance intervals, normal theory and distribution-free approaches. Problems of quality management.



*Statistical System in India.***Paper-VI *Stochastic Process***

Discrete time processes. Random walk. Markov chain, classification of states, steady state probabilities. Branching process.

Continuous time processes. Poisson process. Pure birth process. Birth and death processes. Renewal process. Continuous Markov processes, Kolmogorov equations. Purely discontinuous processes. Stationary processes. (The standard will be approximately that represented by Feller—'Introduction to Probability Theory and its Applications'—Vol. I and Gnedenko—'Theory of Probability').

**Paper-VII *Statistical Inference—II.***

*Selected Topics of Inference, Decision Theory*—Fisher Behrens problem, Scheffe's solution. Stein's two-step sequential procedure. Asymptotic distribution of the likelihood ratio criterion.

Decision Theory. Decision problem and two person game. Decision rules, admissibility, complete class. Bayes rules. Conjugate priors. Minimax rules. Multiple decision problems. Invariance, application to estimation and testing.

Problem of classification into one of two or more multinormal populations.

*Nonparametric Methods*—Nonparametric tests for univariate single sample, two-sample and multi-sample problems, bivariate association problem, and multivariate single-sample and two-sample problems. Theorems on U-statistics. Wald Wolfowitz-Noether Theorem. Statement and application of Hajek's Theorem. Consistency and asymptotic relative efficiency of tests. Statement and application of Chernoff-Savage Theorem.

Nonparametric estimation, point and interval estimates of parameters of location and shift.

**Paper-VIII *Applied Statistics—II.***

*Econometrics*—Stationary time series. Correlogram analysis. Spectrum analysis. Problem of measurement. Single equation models. Simultaneous equations models. Related statistical inference problems.

Analysis of demand, production and cost. Input output analysis. Activity analysis.





**Mathematical Programming**—Linear programming, graphical solution, Simplex algorithm, artificial variables, revised simplex method. Duality Sensitivity analysis. Transportation and assignment problems. Problems of nonlinear programming.

**Demography**—Population data and their adjustment. Stable population theory. Population growth and its measurement. Population estimation and projection.

**The detailed syllabus for the special papers IX and X will be fixed every year. The following lists represent topics that may be included**

**Paper-IX**

**Multivariate Analysis**—Problems of MANOVA, Principal components. Canonical correlations. Distribution of roots of determinantal equations in the null case. Optimal properties of multivariate tests. Characterization. etc. etc.

**Advanced Design and Analysis of Experiments**—Orthogonal arrays. Further results on orthogonal Latin squares. Further results on incomplete block designs. Serial experiments, Asymmetric factorials. Response surface designs. Weighing designs. Optimality of designs. etc. etc.

**Paper-X**

**Advanced Sample Surveys**—Double sampling. Samples taken on successive occasions. Further results on multistage sampling. Further results on nonsampling errors. Choice of sampling unit. Estimates based on distinct units. Varying probability selection without replacement. Unified Theory of Sampling. etc. etc.

**Operations Research**—Analysis of management decisions. Nonlinear and dynamic programming. Inventory Control. Queueing problems. Reliability and replacement. Sequencing. etc. etc.





# Appendix 13

## LIST OF DISTINGUISHED VISITORS

<i>Visitor</i>	<i>Reference relating to &amp; coming from</i>	<i>Visited in</i>
Anderson, R. L.	U. S. A.	1977
Ay, J.	Department of Statistics, Budapest University of Economics, Budapest.	1969
Barlow, R. E.	Prof. of Operations Research, Uni- versity of North Colifornia, at Ber- keley, U. S. A.	1976
Barnard, G. A.	Prof. of Statistics, Imperial College, London.	1956-57
Basu, D.	Statistician, F. A. C., Rome,	1967
Bhattacharyya, B. B.	Senior Professor, North Carolina State University, U. S. A.	1970
Bose, R. C.	Prof. of Mathematical Statistics, Uni- versity of North Carolina, U. S. A.	1961, 1966 1969
Cherafas, Inf. Dimitris N.	Corporate Consultant in Engineering and Management, Paris and Visiting Professor, Information Science and Business Administration, Washington State University, U. S. A.	1966
Cramer, Harold	University, of Stockholm, Norway.	1977
Fisher, Ronald A.	U. K.	1945
Gauld, S. S.	Executive Editor, Mathematical Re- views, The American Mathematical Society, U. S. A.	1961
Ghosh, S. P.	I. B. M., New York, U. S. A.	1969
Govindarajulu, Z.	Associate Professor, Case Institute of Technology, U. S. A.	1966
Haldane, J. B. S.	United Kingdom.	1954
Hoeffding, Wassily	Professor, University of North Caro- lina, U. S. A.	1965
Joneja, R. R.	Technical Advisor, Messrs Phillips India (Private) Ltd.	1960
Linnik, Y. V.	Aademician, Lenningrand Univer- sity.	1965
Masuyama, M.	Japan.	1954
Morimato	Osakacity University, Japan.	1981





<i>Visitor</i>	<i>Reference relating to &amp; coming from</i>	<i>Visited in</i>
Muira, Shin	Chief Quality Control Engineer, Mitsu Chemical Industry Co. Ltd., Japan.	1964
Neuts, Nareel F.	Department of Statistics & Computer Science, University of Delaware, Newark, U. S. A.	1978
Neyman, J.	Prof. of Statistics, University of California, U. S. A.	1956-57
Ott, Ellis	U. S. A.	1958
Panse, V. G.	Statistical Adviser, Indian Council of Agr. Research, Govt. of India, New Delhi.	1959
Pasineetti, L.	Prof. of Economics, Catholic University of Milan, Fellow, Kings College, Cambridge.	1979
Pincus, R.	The Central Inst. of Mathematics and Technology, Berlin, G. D. R.	1979
Roy, S. N.	Prof. of Mathematical Statistics, University of North Carolina, U. S. A.	1953, 1962
Sen, P. K.	Senior Professor, University of North Carolina, Chapel Hill, U. S. A.	1969, 1976 1979
Sidak, Z.	The Institute of Mathematics, Czechoslovak Academy of Science, Prague, Czechoslovakia.	1980
Som, R. K.	The Chief Demographer, United Nations Economic Commission.	1966
Sukhatme, P. V.	Head, Statistics Div., Food and Agr. Organisation, United Nations. Gokhale Inst. of Politics & Economics, Poona.	1954-55 1974
Suzuki, Takeshi	Tokyo University, Japan.	1964
Wald, A.	U. S. A.	1950
Weber, A.	Switzerland.	1954
Wilko, S. S.	U. S. A.	1955
Young, Robert	Indiana University, U. S. A.	1965



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